Approaches to networked learning : an investigation into the nature of autonomous student interaction with web-based educational environments.

Thesis

Link(s) to article on publisher's website:
http://dx.doi.org/doi:10.21954/ou.ro.0000fe23

UNRESTRICTED

Approaches to networked learning: an investigation into the nature of autonomous student interaction with web-based educational environments.

Keith Smyth (BA Hons)

PhD Thesis

Queen Margaret University College & The Open University

February 2006

DATE OF SUBMISSION 21 NOVEMBER 2005
DATE OF AWARD 10 MAY 2006

ABSTRACT

A Networked Learning Environment is an autonomously accessible web resource that combines hypertext course materials, online communication channels, multimedia and other interactive features. Constructivist learning theory makes many claims about the potential of such environments, and the educational 'affordances' inherent within them.

Yet what we understand about the ways in which students learn online, and whether this is conducive to realising the potential benefits on offer, is somewhat limited. Research into learning style differences and attitudes towards online studying provides a partial insight. However, by using tools designed for assessing how students undertake learning in traditional contexts, and through having been predominantly quantitative, much of the research to date can only highlight the relevance of such factors.

Consequently, many questions regarding the how and why of networked learning behaviour remain largely unanswered, and there is a growing consensus that an understanding that is informed by the subjective perspectives of learners is required.

This thesis describes a primarily qualitative investigation that shared this concern. The main research element involved a phenomenographic study that focused on the perceptions, behaviours and experiences of students who interacted with NLEs that were the sole or primary means of course delivery in three undergraduate, campus-based contexts. Two case studies and a naturalistic experiment were conducted, and the phenomenographic study was supplemented with other data relating to assignment grades, online discussion contributions, and preferences for conventional studying.

The phenomenographic analysis identified three distinct types of approach to networked learning that can be seen as increasingly effective in terms of networked learning interactions and outcomes. Based on the findings of the phenomenography, and other aspects of the research, the thesis argues that while many students will experience to some extent the affordances inherent within NLEs, there is an important distinction between students recognising the benefits of networked learning, and actually undertaking this in a way that is conducive to good knowledge development.

This thesis concludes by presenting a theoretical framework that conceptualises the relationship between a range of individual and contextual factors that influence networked learning, and which has a number of implications for theory and practice.

ACKNOWLEDGEMENTS

First and foremost, I would like to thank my wife, Vikki, for supporting me through the completion of the research undertaken, and the thesis itself, in every way imaginable. I know for sure that I would not have made it through to the end of this project otherwise.

I am indebted to my Director of Studies, Ms Kathy Buckner, for consistently offering encouragement, support, and the soundest of advice at every stage. Kathy's support was unstinting even through challenging personal periods when the completion of the research could not always be a priority, and also when I was possibly (almost certainly) being too precious about completing certain aspects of the work. Thank you Kathy.

I would also like to thank my second supervisor, Mr James Herring, for his valuable contribution to overseeing the completion of the work, and for continuing to provide his much-needed support and advice even when he moved to the other side of the world!

Thanks must also go to Prof. Elizabeth Davenport for helping me think through the critical early stages of the research, to Prof. Lindsay MacDonald for kindly granting permission to use his original material as the basis for the online environments designed for the experiment, and to Prof. Colin Suckling for kindly allowing me to use his chemistry class as one of the two case studies. Permission for the other case study was provided by Dr Mark Gillham, who must also be thanked for helping me better prepare for the final stage of examination by putting me through my paces in a mock viva.

I am particularly grateful to the students from Queen Margaret University College and the University of Strathclyde who were kind enough to participate in this study.

At the danger of these acknowledgements running to two pages, I would also like to thank a number of friends, family and colleagues who have helped in various ways, including offering friendly words of support at particular points, helping me talk through various aspects of the work and to prepare for the viva, or simply just listening to me droning on. In no particular order then, thanks to: Dr Karen Qureshi; Prof. Fred Percival, Ms Shirley Earl, Prof. John Cowan; Dr. Christina Mainka, Dr Norrie Brown; Dr Catherine Roberts; Danny Smyth; Mrs C, Scott, Steven, Pamela, Henry, Thomas, Neil, Derek Y, Derek H, Jools, Phill, Paul, Nicola, Bruce, and colleagues in room 101.

A special thanks must go to my colleague Margaret Nairn, who not only prepared this manuscript for printing, but then very generously undertook the printing itself.

Finally I would like to thank Prof. Danny Saunders and Dr Kate Morss for a challenging and enormously constructive viva that has given me much to think about.

For Vikki, Freya and Eva

CONTENTS

LIST OF FIGURES

1.0 INTRODUCTION

1.1 BACKGROUND AND SCOPE

With the emergence and subsequent growth of the Internet, and particularly the World Wide Web, educational researchers, theorists and practitioners have become increasingly interested in networked learning, and networked learning environments (NLEs), as a means of supporting student learning both on campus and at a distance. Jones & Steeples (2002) have observed how the still recent phenomena of computer networks are changing the nature and our understanding of society, and in relation to education simultaneously: redefining the role of the tutor, empowering the student, increasing access to education, allowing for more and better collaborative learning opportunities, and enabling a range of educational technologies to converge in a way that may support learning more powerfully than technology has previously allowed.

A Networked Learning Environment (NLE) is an autonomously accessible hypertext-based resource, delivered via the web, which combines comprehensive course materials with computer-mediated channels for student-student or student-tutor communication and, ever more frequently, multimedia and other interactive features and tools. Contemporary learning theory in the constructivist vein makes many claims about, or which apply to, the educational properties of NLEs and their constituent elements, and the benefits students should experience as a result of interacting with them. These benefits include the enhanced understanding that is thought to be associated with the opportunity for self-paced learning, the personally relevant learning that can result from the needs-based exploration of educational hypertext material, the various cognitive benefits that have been associated with visual multimedia, and the in-depth, critical understanding that can be enabled through participation in asynchronous discussion. In general terms, the rationale for having students interact with NLEs is to facilitate an active, learner-centered educational experience that immerses the learner in the personal construction, as opposed to the passive acquisition, of knowledge.

In recent years the concept of 'affordances' that originates from the perceptual theory of the psychologist James Gibson has been adopted by an increasing number of theorists and researchers in seeking to explain the potential of educational technology to support and facilitate effective student learning. In relation to educational technology, we think of an affordance as being the opportunity for action and extended learner capability that is inherent in the properties of a specific technology or media (Ryder & Wilson, 1996).

However the potential for NLEs to support active, effective learning can arguably only be realised if the learner acts upon the affordances inherent within them. Unfortunately the research to date has found that many students often utilise networked and other technology-based educational environments in less than effective ways.

The literature offers some insight into why this might be happening. Research into the effects of cognitive and learning style differences upon interaction with educational technology tends to indicate that only those students who are amongst the more focused and self-dependent minority will fully utilise the resources at their disposal, and as a result often have better learning outcomes than their less active or less independent peers. In addition attitudinal research has shown that despite often enjoying or appreciating aspects of what networked learning offers and involves, many students find it hard to become motivated to study online and dislike the increased responsibility this involves.

Yet much of the research in these areas can do little more than acknowledge the potential relevance of these factors and issues, as it has been limited in many key respects, including a relative lack of qualitative research into the student experience.

The research reported within this thesis was conducted to address these shortcomings on a modest scale. Employing an interpretative, phenomenographic method as the principle means of data collection and analysis, the investigation focused on the perceptions, behaviours and experiences of students interacting with autonomously accessible NLEs that were the sole or primary means of course delivery in three undergraduate, campus-based contexts. Two of the research contexts comprised modules from otherwise largely conventionally taught chemistry and information management programmes. The third was an exploratory naturalistic experiment that looked at specific aspects of the networked learning experience, including whether certain NLE features can influence the extent to which learning actually occurs online.

Accepting the tenets of constructivist learning theory and claims made for the affordances of NLEs as a starting point, this investigation seeks to establish whether the students involved experienced the benefits the literature would have us expect, and what instructional factors positively or negatively contributed towards how networked learning was undertaken and perceived. Through a rigorous phenomenographic analysis of the accounts each student provided through individual interviews, an understanding of the different networked learning characteristics and traits exhibited is then sought, and the possible relationship between them conceptualised.

In satisfying the principal aim of the research, the thesis attempts to consolidate the main findings of the investigation within a proposed framework that will seek to help lay the foundations for understanding the relationship between individual approaches to networked learning, interaction with NLEs, and the environment itself in determining the nature and effectiveness of the autonomous networked learning experience.

1.2 AIM AND OBJECTIVES

The aim of this research is to develop an understanding of the relationship between individual approaches to autonomous networked learning, interaction with networked learning environments (NLEs) and their features, and networked learning outcomes.

In striving to meet this stated aim, the principal objectives informing the nature of this investigation can be understood in terms of the following specific research questions:

i. Under autonomous conditions, do students generally benefit from the educational properties that are thought to be inherent in NLEs and their constituent elements?

ii. What factors associated with the instructional context are perceived to influence the educational effectiveness of interacting with NLEs and their constituent elements?

iii. Do individual students have diverse ways of approaching networked learning indicative of preferred networked learning styles? If so, do they reflect approaches to learning on conventional courses, and influence networked learning outcomes?

In addition, partly because NLEs integrate multiple technologies within a single educational environment, a further research question pertinent to this investigation is:

iv. What factors intrinsic to the individual and the environment itself influence frequency of interaction with NLEs, and the extent to which this occurs online?

1.3 STRUCTURE OF THESIS

This thesis comprises ten chapters, with the main content being presented in this and the following seven. Chapter 2, the literature review, begins with a brief overview of theoretical perspectives on learning in order to introduce the ideas and beliefs that have shaped what is understood about the nature of learning in educational contexts. An examination of constructivist learning theory, the currently dominant perspective and the one that is most relevant to thinking and practice in relation to educational technology, is facilitated by considering the characteristics of what are commonly termed constructivist learning environments. This leads into a discussion on the nature of networked learning environments, which introduces the concept of affordances before examining the extent of the empirical support for the claims the contemporary theory makes about the educational benefits inherent within them. The literature review concludes with a focus on research into learning styles, including specifically previous phenomenographic work on approaches to studying, and what is currently understood about the influence of learning styles upon how students use educational technology.

Chapter 3 describes the methodological approach taken, and addresses rationale, design, data collection and analysis, and general issues in reliability and validity. The findings of the investigation are presented in Chapters 4 to 6, each of which addresses specific research questions. Chapter 4 presents the results pertaining to general perceptions of autonomous networked learning, including the perceived benefits and the instructional factors that were felt to have had an influence upon the experience. Chapter 5 presents the main findings of the research, and concerns the approaches to networked learning that were identified through the phenomenographic element of the investigation. An identification of the approaches leads into various analyses concerning their influence upon individual students, the realisation of networked learning affordances, networked learning outcomes, and their possible relationship with approaches to conventional studying. Finally Chapter 6 addresses networked learning 'mode of interaction', and looks at the factors that influenced, and were influenced by, the frequency of networked learning interactions and the tendency to study mediated course material on or offline.

Chapter 7 draws together the main findings of the investigation in presenting the content for a proposed theoretical framework which conceptualises the nature of autonomous networked learning as an inter-relationship between individual approach to networked learning, mode of interaction, and the environment itself, and which when more appropriately formatted for dissemination may help inform practice and research.

Chapter 8 concludes the thesis by considering the reliability and validity of the main findings, their implications for the field, and possible directions for the continuation of the research reported herein. Chapters 9 and 10 contain the appendices and references, while Chapter 11 contains the papers that have already been published from the thesis.

2.0 LITERATURE REVIEW

2.1 THEORETICAL PERSPECTIVES ON LEARNING

In the field of education, our understanding of what learning is and how it occurs is widely acknowledged to have been shaped by three distinct theoretical perspectives that have dominated thinking at various points during the last century or so: behaviourism, cognitivism, and constructivism (Ertmer & Newby, 1993; Tennyson & Schott, 1997; Wilson & Meyers, 2000). All offer unique definitions of learning, and their respective conceptualizations of the learning process have important implications for current thinking on how learning in educational environments is effectively enabled.

2.1.1 BEHAVIOURISM

Behaviourism, as a theory of learning, emerged in the early nineteen hundreds. As theorists fought to establish psychology as a serious area of scientific study comparable in approach to the physical sciences, they chose to focus on overt behavioural phenomena that could be observed and measured rather than abstract notions of mind and consciousness that were considered 'unknowable' [1] (Good & Brophy, 1990; Schunk, 1996). Behaviour was viewed as consisting of responses to external environmental stimuli perceived by the senses, with associations formed between stimuli and responses determining the probable nature of future behaviour. This basic stimulus-response conditioning proposition is the central concept within behaviourism, and a common element within the theories of the movement's founders (e.g. Watson,

[1] Molenda (1997) observes how the epistemological foundations of behaviourism lie in the philosophical position of empiricism, which holds that knowledge of the real world arises out of experience. This contrasts with rationalism, which holds that at least some knowledge derives from reasoning and therefore can exist independently of experience (p. 49-50).

1924; Thorndike, 1932). Much early behaviourist research involved Pavlovian-style experiments on the formation of behavioural responses within animals, and as a consequence provided little insight into human learning (Good & Brophy, 1990). However, behaviourist principles were gradually applied in explaining human learning, and the most significant theorist in this respect was Skinner (1953; 1954; 1968).

Skinner's (1953) operant conditioning model contends that behaviours can be shaped through a process of reinforcement, and comprises a three-term contingency in which a discriminative stimulus in the environment results in a behavioural response, which is then followed by a positive or negative reinforcing stimulus. In an educational context, if a student correctly answers a teacher's question, they will receive positive verbal feedback that increases the probability of that response being emitted when the same discriminative stimulus, in this case the same question, is presented on future occasions.

To the extent that behaviours can be reinforced, then in behavioural terms learning is the strengthening of associations between environmental stimuli and the overt responses an individual makes in their presence, the implication for facilitating learning in educational environments being that "teaching is the arrangement of contingencies of reinforcement under which students learn" (Skinner, 1968, p. 64-65). Within Skinner's basic instructional model, the starting point is for the teacher to determine the desired terminal behaviour of the learner, or what they should be able to do as a result of being taught, before sequencing and presenting content in the order of incremental steps deemed necessary to achieving the desired goal. Students demonstrate their understanding following each instructional increment, and receive immediate positive or negative reinforcement as appropriate. The instructor facilitates the transfer of previously-acquired knowledge to new contexts through making minor alterations to a discriminative stimulus, which then allows the 'generalisation' of previously learned responses to progressively dissimilar stimuli (Skinner, 1954, 1968).

The emphasis behaviourists placed on structuring the educational environment to increase the probability of the desired learning occurring laid the foundations for contemporary instructional design theory (IDT) (Reigeluth, 1983; Tennyson & Schott, 1997), and in the work of Skinner and his predecessor Thorndike (1932) some of the earliest prescriptive theories relating to curriculum design and instructional principles are to be found. Although a full appraisal of behaviourism is outwith the scope of this thesis, the movement is of historical importance due both to its premise regarding the nature of learning, and subsequent influence upon the development of IDT

2.1.2 COGNITIVISM

Behaviourism was the dominant school of thought on learning until the late 1950's, when psychologists began questioning the validity of models that explained learning purely in terms of overt responses to environmental stimuli, and failed to account for such phenomena as memory and recall, concept formation, problem solving and intellectual development (Ertmer & Newby, 1993; Schunk; 1996). Although behaviourism and cognitivism share a common interest in the environmental conditions that affect learning, cognitive learning theory focuses instead on "describing the intervening cognitive approaches and structures" that explain the relationship between "instructional manipulation" and "outcome performance" (Mayer, 1987, p. 5) [2].

[2] In this respect the epistemological foundations of cognitivism and associated theories of learning are closer to the philosophical position of rationalism than that of empiricism (Ertmer & Newby, 1993; Molenda, 1997).

Cognitivism has made several major contributions to our understanding of how learning occurs and can be enabled, central to which are those theories that address the processing and structuring of knowledge within the mind. Information processing theories (Atkinson & Shiffren, 1968; Lindsay & Norman, 1972) view human memory as consisting of three distinct components. Sensory memory receives information from the environment via the senses, and immediately transfers it to short-term, or working, memory for interpretation. Short-term memory is akin to awareness and is limited in capacity, whilst any information that is or has been retained for more than a few minutes resides in long-term memory, which may be unlimited in capacity and is generally accepted as being the locus of all learned experience [3]. Although deliberate rehearsal of information within short-term memory can result in its transition to long-term memory, the main method of transition is through meaningful integration of information with existing knowledge structures in the form of 'propositional networks' and 'schemas'.

Propositional networks are associative semantic structures that link together related pieces, or nodes, of verbal information within memory records called propositions: the smallest units of knowledge that can be judged true or false. The nodes within a network may be thought of as ideas, whereas the links between nodes are the associations between ideas, for example the simple propositions robins-are-birds, birds-have-feathers (Anderson, 1990, p. 131). The interconnected nature of propositional networks means that when information is recalled, such as in response to something read or asked, we attend to the relevant concept first before related information is primed for recall. Termed the 'spread of activation', this explains why when thinking

[3] Schunk (1996) acknowledges alternative theories of human information processing, some of which dispute the belief that long term memory is unlimited in capacity, but notes that this model provides a useful and generally accepted framework for thinking about how information is processed and stored (p. 152-153).

of the concept 'dog', associative links to 'bone' and 'cat' will be triggered in a sequence determined by the strength of the associations in long-term memory (Ibid, p. 160-161).

Three distinct forms of propositional knowledge are thought to be stored within long-term memory. Declarative knowledge includes facts and subjective beliefs, procedural knowledge our understanding of concepts and rules, and conditional knowledge our cogency about when to employ specific types of procedural and declarative knowledge[4]. Conditional knowledge is intrinsic to the higher order mental ability of metacognition. Metacognition is essentially an individual's self-awareness of their own cognitive processes, combined with an ability to monitor and optimise the approach taken to completing specific tasks within a particular context (Flavell, 1985, 1987).

Anderson (1990; 1995) observes how the context-specific nature of propositional networks would limit our ability to understand and make inferences about concepts and situations were it not for larger-order units called schemas. Schemas are "integrated bodies of knowledge that are relevant to a limited domain" (Norman, 1982, p. 51), and represent the general properties of concepts, objects and events. For example, an individual might possess schemas for solving mathematical problems, or for the layout of keyboards. Schemas guide information coding and retrieval because as new information is presented, existing schemas enable it to be assimilated into a meaningful structure. This is the basic nature of learning from a cognitive perspective, which can be seen as a process of knowledge accretion, restructuring, and tuning (Rumelhart & Norman, 1978; Norman, 1982). Accretion is simply the addition of new knowledge to an existing schema without alteration to the conceptual structure of the schema in

[4] This is a general definition of the types of knowledge stored within long-term memory, as there is some variation within the terminology used by different theorists. For example Mayer (1987) refers to semantic, procedural and strategic knowledge. Reigeluth & Moore (1999) provide a detailed overview of taxonomies pertaining to types of knowledge, but the distinction between knowing what, knowing how and knowing when is consistent.

question; restructuring is the formulation of new conceptual structures that occurs when existing schemas will no longer adequately accommodate new or existing knowledge; and tuning is the fine adjustment of a schema to enable more efficient performance on a particular task, and has been equated with the "change that occurs in transforming a person knowledgeable about the task into one who is expert" (Norman, 1982, p. 89).

Because in cognitive terms learning is the expansion and reorganisation of propositional networks and schemas, the goal of instruction is to structure and present knowledge in the manner most expedient to successful learning. Ausubel's (1963; 1968) theory of meaningful reception learning, which related primarily to the learning of oral or written material in the classroom, was one of the first major cognitive theories to address this concern. The theory advocates: presenting the general concepts within a domain at the outset to provide suitable 'anchorage' for the subsequent comprehension and interrelating of ideas; proceeding in small steps of increasing task or conceptual complexity; and using a range of examples and non-examples to hone understanding [5]. Ausubel believed learning could be further aided by making advance organisers, general statements outlining the content of material and connections amongst topics, available at the outset in order to activate the relevant prerequisite knowledge so that it may "play a subsuming role in relation to the new material" (Ausubel, 1968, p. 157).

The continued relevance of the instructional principles cognitivism first introduced is evident within current IDT. Whilst the behaviourist and cognitivist perspectives are different conceptualisations of learning itself, instructional design theories aim to be more easily applicable to instruction as "they describe specific events outside of the

[5] Although behaviourist and cognitivist instructional design models both emphasised the incremental structuring of content, as the models of Skinner (1954) and Ausubel (1968) show, cognitivist models focused on optimising the development of existing knowledge structures as opposed to expanding a repertoire of overt behavioural responses.

learner that facilitate learning (i.e. methods of instruction) rather than describing what goes on inside a learner's head when learning occurs" (Reigeluth, 1999, p. 13). However, IDT is grounded within cognitive learning theory, and a general acceptance of information processing and schema theories underpins the work of the prominent theorists (e.g. Gagne, 1985; Gagne et al, 1992; Merrill, 1994; Reigeluth, 1999). In this respect IDT is a "prescriptive science...linking basic research in the psychological processes of learning with concrete solutions to educational problems such as optimising learning retention and transfer" (Tennyson & Schott, 1997, p. 3) [6].

IDT offers prescriptive guidance at a number of levels. Starting at the broadest, it is possible to differentiate between theories that: address 'instructional systems development' (Shiffman, 1995; Reigeluth, 1999); explain the requisite conditions for learning and instruction (Gagne, 1985; Gagne et al, 1992); and concern the macro and micro levels of instruction that respectively relate to the sequencing of subject matter topics, and designing instruction for single facts or ideas (Reigeluth & Merrill, 1978).

Instructional systems development theory takes a holistic approach historically influenced by systems engineering, and views the learners, instructor, instructional materials and the learning environment as components of the instructional system, with the aim being to optimise the efficiency with which they interact (Schiffman, 1995). Dick & Carey's (1996) Systems Approach Model for Designing Instruction is perhaps the best known model of this type, and focuses on optimising instructional efficiency by accounting for the contribution each of these components makes (p. 4).

[6] The original conception of a 'linking science' between learning theory and educational practice came from the American educationalist John Dewey (1910).

According to Gagne et al (1992), the stages involved in instructional systems development can be categorised into three functions: identifying instructional outcomes; developing the instruction; and evaluating instructional effectiveness (p. 21). Table 01 shows the steps in the Dick & Carey model with the stages identified by Gagne et al

TABLE 01: STAGES IN SYSTEMS APPROACH MODEL FOR DESIGNING INSTRUCTION

Systems Approach Model for Designing Instruction	Stages of Instructional Systems Approach
1. Identify an instructional goal 2. Conduct an instructional analysis 3. Identify entry behaviours and characteristics 4. Write performance objectives	1. Identify outcomes of instruction
5. Develop criterion-referenced assessments 6. Develop an instructional strategy 7. Develop or select instruction	2. Develop the instruction
8. Design and conduct formative evaluation 9. Design and conduct summative evaluation	3. Evaluate the effectiveness of instruction
Source: Dick and Carey (1996)	Source: Gagne et al (1992)

The specific events of instruction that instruction should be designed to support are a key component of Gagne's (1985, originally 1965) influential conditions of learning theory. This contends that there are five type of learning outcome comprising verbal information, intellectual skills, cognitive strategies, attitudes and motor skills. To support the attainment of any learning objective it is first necessary to identify the type of outcome it represents, before then identifying the internal knowledge requirements and external conditions essential to it being achieved. Regards the external conditions of learning, Gagne (1985; et al, 1992) believes that although their precise nature is dependant upon the desired outcome, the same nine events of instruction can support all types of learning. These events and their internal processes are summarised in Table 02.

TABLE 02: EVENTS OF INSTRUCTION AND THEIR INTERNAL LEARNING PROCESSES

Instructional Event	Relation to Internal Learning Process
1. Gaining attention	A stimuli is presented to alert the learner to the impending instruction, e.g. a demonstration intended to provoke interest, and thus ensure its reception.
2. Informing learner of the objective	Activates a process of 'executive control', which enables the learner to select strategies appropriate to the learning objective they are expected to achieve.
3. Stimulating recall of prerequisite material	To facilitate the appropriation of new knowledge to established schemas learners are primed to recall relevant existing knowledge, e.g. via a recall task.
4. Presenting the stimulus material	The course content is displayed or communicated in an appropriate form, e.g. facts for a historical event, or examples and non-examples for concept learning.
5. Providing learning guidance	Semantic encoding is supported through hints or questions that stimulate the correct 'line of thought', e.g. discovering a common rule, conceptual linkages.
6. Eliciting the performance	Following the point at which the learner is deemed to have received sufficient guidance, they are required to demonstrate their level of understanding.
7. Providing feedback about performance correctness	Learning reinforcement is established based upon the degree of correctness in the learner's demonstration, with feedback provided instantly whenever possible.
8. Assessing the performance	To objectively assess the learner's ability to retrieve the desired knowledge in the required context, the learner completes a criterion-referenced assessment.
9. Enhancing retention and transfer	Retention is assessed via periodic reviews during a course of instruction, and transfer facilitated through introducing new contexts to apply knowledge within.
Source: adapted from Gagne (1985), Gagne et al (1992)	

For Gagne (1985, et al, 1992) it is the responsibility of the teacher or instructional designer to deliberately arrange the events of instruction in the manner most appropriate for a particular learning objective. The central premise of the conditions of learning theory is that learning occurs via internal cognitive processes, but that these processes are subject to external influences such as information being presented in a meaningful sequence, at an appropriate level of detail, and with the aid of reinforcing activities. As it is this influence that makes instruction possible, instruction "may be conceived as a deliberately arranged set of events designed to support internal learning processes" and "lead to rapid, obstacle-free learning" (Gagne et al, 1992, p. 11).

Although contemporary IDT illustrates the continued importance of cognitivist beliefs about learning, many cognitivist assumptions, particularly concerning knowledge and memory, are also central to what is known about learning via educational technology

2.1.3 CONSTRUCTIVISM

The transition from behaviourism to cognitivism signified a major paradigmatic shift in how learning was conceived. Yet towards the end of the 1980's a number of theorists, writing under a banner that became referred to as constructivism, began to question whether the change in thinking that accompanied cognitivism really did adequately explain the true nature of learning (e.g. Greeno, 1989; Jonassen, 1991; Duffy & Jonassen, 1992a). Specifically it was suggested that cognitive theory, including prescriptive IDT, shared with behaviourism an objectivist assumption that the world is real, exists externally to the learner, can be modelled through the use of words and other abstract symbols, and that "learning consists of grasping the referents of words, that is, the kinds of entities or concepts that the words denote in reality" (Jonassen, 1991, p. 9).

In essence a philosophical position, constructivism, as converse to objectivism, does not reject outright the notion of the 'real world' but contends that what we understand about the world is based upon our own unique perceptions of it. Rather than existing independently of and being transferable to the mind, knowledge is constructed within the mind as a direct result of an individual's interactions with the world (Duffy & Jonassen, 1992a; Bednar et al, 1992). Learning is seen as grounded in the perception of physical and social experiences, with our interpretation of events, objects, and perspectives resulting in a highly personal knowledge base that indexes our past perceptions and guides future learning (Jonassen, 1991). Based on the assumption of individuals forming unique perceptions, an extreme constructivist viewpoint is that since "there are many meanings or perspectives for any event or concept. Thus there is not a correct meaning for what we are striving for" (Duffy & Jonassen, 1992, p. 3).

Within education, constructivism does not represent a unified theory of learning, but a collection of theories and ideas that share the aforementioned basic assumptions, and in doing so reject one-to-many didactic methods of teaching in favour of a 'learner-centred' approach. Yet despite the status of constructivism as the currently dominant perspective on learning, its epistemological foundations lie in the work of a number of early cognitive theorists including Jean Piaget, Jerome Bruner and Lev Vygotsky.

Piaget's (1978) theory of genetic epistemology, the growth of knowledge in a person, viewed cognitive growth as relative to existing knowledge. Rather than new information being directly perceived, it is interpreted in terms of what the individual already knows as they interact with their environment and strive to maintain a state of mental equilibrium. In order to do so the individual must resolve the tension between the dialectical processes of assimilation, or the interpretation of new information, and accommodation, which involves restructuring existing knowledge to facilitate this interpretation and form a coherent, meaningful understanding [7]. Piaget's theory was concerned with the stages of intellectual development from infant to adulthood. As he viewed this as a progression in the complexity of information processing and representation ability, the basic focus of his theory may be thought of as a fundamentally constructivist process in itself. However it is Piaget's notion of the relative nature of knowledge, and resolving the disparity between new knowledge and that already known, that encapsulates an important part of the constructivist perspective.

[7] A description echoed in Rumelhart & Norman's (1978) stages of knowledge accretion, restructuring and tuning.

The emphasis on interpreting that perceived against that known also underpins Bruner's (1961; 1974) discovery learning theory. This views effective learning as an active process of guided inquiry that requires the learner to create their own meaning by engaging in tasks that involve applying concepts, testing hypotheses and solving problems, as opposed to passively receiving information. An important concept of Bruner's is 'beyond the information given'. The premise is that an individual's existing knowledge structures enable the assimilation of new information but can also, if developed to a suitable complexity, allow the individual to infer relationships, predict effects, and "permit the maximum reconstruction of material unknown to the reconstructor" (Bruner, 1974, p. 236) [8]. The notion of going beyond the information given is fundamental to constructivism, and what contemporary theorists refer to as 'constructivist learning environments' (Wilson, 1996; Hannafin et al, 1997; Jonassen, 1999).

While the theories of Piaget and Bruner considered learning from the perspective of the individual, the focus of Vygotsky's (1978) sociocultural theory is on understanding learning as the result of an individual's interaction with society. The main contention is that the social environment mediates learning through providing the cultural tools, such as language, institutions and objects, that make cognitive activity possible. Through using these tools in the course of social interaction with, for example, teachers and peers, understanding is generated and then internalised by the learner. Vygotsky's most famous concept is the "Zone of Proximal Development", which he defined as "the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving

[8] Constructivism does not question the idea of knowledge existing in the mind in the form of semantic networks. Both Piaget and Bruner believed knowledge to be organised in this way, as do contemporary constructivist theories that focus on learning in the cognitive domain (e.g. Cognitive Flexibility Theory). The point of departure for constructivism concerns the design of course content, and rejection of the notion that by structuring and presenting knowledge according to a perceived reality each learner will arrive at a comparable understanding.

under adult guidance or in collaboration with more capable peers" (p. 86). The implication for instruction, that an individual's ability to master concepts or ideas is increased through an appropriate level of support from more knowledgeable learners, has been a major influence upon constructivist theories that emphasise the social dimension of learning such as cognitive apprenticeship theory (Collins et al, 1991).

In contrasting the theories of Piaget and Bruner with Vygotsky, there is an important distinction to be made between individual constructivism and social constructivism [9]. This is reflected within recent constructivist theories that focus on knowledge construction within the context of the individual, such as cognitive flexibility theory (Spiro et al, 1991; Jacobson & Spiro, 1995), or of the individual during social interaction, for example situated cognition (Brown et al, 1989; Wilson & Myers, 2000). Each perspective shares the same basic assumptions about the nature of learning and understanding, but provide insights into different ways this can effectively occur.

2.2 CONSTRUCTIVIST LEARNING ENVIRONMENTS

At the core of contemporary constructivist learning theory are three propositions. The first is that individuals learn as a result of their interactions with the learning environment, so that understanding becomes a product of the content and context of learning, in addition to the goals of the learner. Secondly, dissonance between current knowledge and the goal of the learning environment, e.g. solving a problem, provides the stimulus for learning and determines what features of the environment are attended to, the prior knowledge employed, and that which is ultimately constructed. The third proposition is that knowledge evolves through social interaction, a process that is

[9] Ertmer & Newby (1993) observe this distinction, and note that whilst the philosophical roots of behaviourism lie in empiricism and those of cognitivism in rationalism, constructivism straddles both positions by emphasising the role of the mind and the role of experience in perception.

critical to evaluating our own constructions and those of others as we strive to expand our understanding (Savery & Duffy, 1996, p. 136).

These propositions are fundamental to the range of theories and beliefs within the constructivist movement, which can best be addressed through considering the characteristics of what the literature has come to term 'constructivist learning environments' (Wilson, 1996; Jonassen, 1999; Woodard, 2003) [10]. Wilson (1996) defines a constructivist learning environment as "a place where people can draw upon resources to make sense out of things and construct meaningful solutions to problems" (p. 3). Their main attributes are generally accepted to include: increased student autonomy; authentic tasks and contexts; opportunities for social collaboration; exposure to multiple perspectives; encouragement of self-reflection; authentic forms of assessment; and technological support (Lebow; 1993; Grabinger & Dunlap, 1995; Honbein, 1996; Hannafin et al, 1997; Jonassen; 1999; Hannafin & Land, 2000).

The theories and beliefs that underpin these principles provide the basis for many claims regarding the educational benefits of technology-based learning environments, and so an appraisal of each is necessary to fully appreciate the potential benefits of NLEs.

[10] This reflects a trend in the current literature on constructivism, much of which discusses constructivist learning theory and instructional principles in the context of designing (primarily technology-based) learning environments.

2.2.1 INCREASED STUDENT AUTONOMY

Traditionally the instructor is responsible for major decisions relating to the what, when and how of learning, including the breadth and depth of course content, the ordering of topics, and resources to be utilised. From a constructivist viewpoint this is problematic as the learner may simply accept and follow instruction without giving much critical thought to what they are learning, and certainly with less than would occur if they were more personally responsible for their learning. As Dunlap & Grabinger (1996) observe, "it is customary for instructors to set the goals, plan the objectives, select the strategies, ask the questions, and evaluate the work. The irony is that these tasks are all high-level cognitive abilities involving analysis, synthesis, evaluation, application and assimilation...the kinds of activities that we want students to perform" (p. 69).

To ensure learning is more effective than it might be under fully instructor-imposed parameters, one option is for the learner to be given the freedom, with tutor guidance, to formulate their own learning objectives and decide upon the activities to be completed. Savery & Duffy (1996), believing that the goals of the individual ultimately determine what is learned [11], feel the advantage of this is in ensuring a close correlation between the desired instructional outcomes and the motivations and interests of the learner. Rather than simply concentrating on passing a test or spending the requisite amount of time on task, which may result from learners failing to fully adopt instructor-set objectives, the learner instead has a vested interest in the goals and activities of learning through their involvement in determining them. For constructivists, increased ownership of the learning goal is critical to successful learning, as it provides students

[11] This will become apparent when addressing the issue of individual learning styles and approaches to studying, particularly in relation to the nature and effectiveness of learning via networked learning environments.

with the "primary responsibility for noticing what is important and what must be learned to accomplish a given task" (Honebien et al, 1993, p. 91).

Lest this seems to advocate learners being allowed to fully determine their own objectives, which is impractical where progressing through a syllabus is a concern, a viable alternative is to present learners with problems or activities that they can adopt as their own. Invariably described as 'ill-structured' (Jonassen, 1999; Barab & Duffy, 2000), activities of this type are loosely defined by the instructor so that the locus of control for managing learning lies with the student. This could mean that the learner is responsible for deciding what to do in order to successfully satisfy the learning objectives, including which topics to focus upon, which resources to use, and the time allocated to particular tasks (Dunlap & Grabinger, 1996). According to Lebow (1993), environments that support autonomy encourage and are more likely to be associated with an active, intrinsically motivated, intentional approach to learning.

2.2.2 AUTHENTIC ACTIVITIES AND CONTEXTS

The notion of 'authenticity' permeates constructivist theory, and reflects a concern with ensuring the knowledge developed in an educational context will be of value within the real world environment for which the learner is preparing (Honebein et al, 1993). The issue is one of effective knowledge transfer, and in relation to learning activities this is facilitated through having the learner undertake tasks that require them to think like a subject expert. In the domain of geography, for example, the goal "should not be to teach geography principles or geography facts, but to teach students to use the domain of geographic information as a geographer, navigator or cartographer might do" (Bednar et al, 1992, p. 23). The argument in support of authentic learning activity is the countenance of "inert knowledge" that is of little use outside the instructional context in which it was acquired, and which constructivists associate with instruction involving the sequential presentation of abstracted domain content via didactic lectures and simplified textbook-style exercises (Grabinger & Dunlap, 1995; Land & Hannafin, 2000) [12].

In constructivist terms, the idea of activities being authentic usually implies that they are ill-structured. Defined by multiple possible paths of enquiry, a degree of uncertainty about which concepts and rules are applicable, and requiring learners to defend their own opinions, activities of this kind provide a clear focus for learning from the outset "rather than acting as an example of the concepts and principles previously taught", and often take case and problem-based forms (Jonassen, 1999, p. 218).

In case-based learning an individual or group is presented with a narrative concerning an event, and is then required to apply their knowledge of concepts and principles to exploring the narrative and arriving at a defensible view. The rationale is for the learner to develop a contextually indexed knowledge base that will constitute a valuable resource for reasoning in new or varied situations (Jarz et al, 1997; Schank et al, 1999; Kolodner & Guzdial, 2000). In problem-based learning, students are presented with a problem prior to any substantial instruction or exposure to material. Usually working in small groups, the problem is first analysed to identify specific areas for study, and the resulting knowledge is then reapplied in an attempt to solve the problem (Boud, 1985; Boud & Feletti, 1991). Through increasingly self-directed study the learner builds a substantial base of existing and new knowledge, and in collaboration with their group

[12] The term "inert knowledge" was originally used by Whitehead (1929) to refer to knowledge that learners can recall when explicitly asked to do so, but which they would fail to spontaneously recognise as relevant in new situations.

refines what is collectively understood until the group is able to debate and produce possible solutions (Savery & Duffy, 1996; Grabinger et al, 1997) [13].

An important point concerning authentic activity is that it should not attempt to replicate specific real-world tasks, as this would limit the transferability of knowledge to new situations (Honebein, 1996; Jonassen, 1999). Instead authentic activities should only attempt to typify real-world tasks, both in terms of content and also the materials and resources that are available to the student. One constructivist pedagogy noted for taking such a holistic view of learning task and learning context is anchored instruction.

Anchored instruction is a strategy for actively engaging students in learning by centring activity around "a focal event or problem situation that provides an anchor for students' perceptions and comprehension" (Bransford et al, 1990). Illustrative of this approach is the interactive videodisk-based Jasper Woodbury Problem Solving Series (CTGV, 1990, 1993a, 1993b). Using a "generative learning" format, students view the narrative and discuss solutions in small groups, the intention being for them to notice critical features of the problem and experience changes in understanding as they view the situation from new viewpoints. Instantiating the anchor in interactive media, as opposed to using a verbal mode of transmission, is claimed to have a number of instructional advantages. These include making the material more motivating and interesting to interact with through depicting characters and settings realistically, and to facilitate the learner expediently revisiting sections of the narrative and associated materials (CTGV, 1992, 1993a). In this respect anchored instruction exemplifies the roles that technology can play in contributing to both the authenticity and degree of autonomy within constructivist learning environments.

[13] Problem-based learning of this type was a substantial part of the activity in one of the case studies for this thesis.

In common with anchored instruction, cognitive apprenticeship (Brown et al, 1989; Collins et al, 1991) also advocates generative learning within the completion of authentic tasks. However cognitive apprenticeship focuses on the tutor-student relationship, with the tutor playing a guiding role in teaching abstract tasks in realistic forms using realistic materials, and varying the diversity of situations in which tasks are undertaken so learners can generalise their understanding to new scenarios.

The emphasis anchored instruction and cognitive apprenticeship place upon fostering transferable knowledge reflects the core constructivist belief that knowledge is inseparable from the conditions of its development. This premise is at the heart of situated learning theory, which contends that learning is quintessentially a social process, and that outwith the sphere of decontextualised instruction what we come to understand is shaped by the activities we undertake within the socio-cultural contexts in which we function (Lave, 1988; Lave & Wenger, 1991) [14]. The implications for learning environments that arise from a full consideration of the situated learning theory perspective are numerous (Wilson & Meyers, 2000), but in addition to authentic tasks and contexts a key principle is that effective learning depends upon social collaboration.

2.2.3 SOCIAL COLLABORATION

For constructivists, student collaboration can enhance learning by allowing important social learning processes to occur. Brown et al (1989) identify these as collective problem solving, the displaying of multiple roles, confronting ineffective strategies and misconceptions, and providing collaborative work skills. These processes enable groups to transcend the construction of individual knowledge to give synergistic rise to

[14] Anchored instruction and cognitive apprenticeship are applications of situated learning principles.

insights that may not otherwise occur, and allow the individual to develop in their ability to understand and assume different responsibilities relative to particular tasks (p. 40).

Collaboration can result in more than the sum of individual viewpoints due to the critical, reflective nature that characterises group discourse. As Slavin (1996) states, "students will learn from one another because in their discussions of the content, cognitive conflicts will arise, inadequate reasoning will be exposed, disequilibration will occur, and higher-quality understandings will emerge" (p. 49). The process is one of reconciliation between the knowledge of the individual and that of their peers. According to Edelson et al (1996), verbalising an idea requires the learner to impose a structure upon what they understand, which may lead to them identifying gaps in their knowledge or forming new associations between ideas. During a group discourse, this process is "amplified" to become a more rewarding shared cognitive effort (p. 152).

The claim that collaboration can result in greater depth of understanding is supported by empirical research. Slavin (1987) and Garside (1995) cite a number of studies in which collaborative learning resulted in increased academic achievement, with the latter's own research indicating this was particularly notable regards the ability to think critically about phenomena. Unsurprisingly then, constructivists consistently stress the need for learning environments to incorporate some aspect of collaborative activity or discourse (Grabinger & Dunlap, 1995; Edelson et al, 1996; Jonassen, 1999; Gillani, 2003).

While the major claim regarding the collaborative working dynamic is that students can come to understand and achieve more than the individual working alone [15], the issue of

[15] This is the essence of Vygotsky's (1978) Zone of Proximal Development, or the potential level of cognitive development achievable through collaboration with more capable learners or tutors.

learner scaffolding or support is also important. When students work in groups they can be increasingly willing to take on the complex tasks that characterise constructivist environments, and so are more likely to realise learning goals that would be difficult to attain alone (Grabinger & Dunlap, 1995). However, this does not imply that in realising group goals the value of collaboration is in students arriving at the same agreed understanding. Instead the value lies in the group thinking process itself. As Bednar et al (1992) state "consensus is not the goal of collaboration; rather, it is to develop, compare and understand multiple perspectives on an issue" (p. 28).

2.2.4 MULTIPLE PERSPECTIVES

Although exposure to and appreciation of multiple perspectives can be facilitated through collaborative activity, constructivism offers another approach for doing so. This is for multiple perspectives of an elaboratory and contradictory nature to be instantiated within conceptually complex course materials. This is the focus of cognitive flexibility theory (CFT) (Spiro et al, 1987; 1991; Spiro & Jehng, 1990; Jacobson et al, 1996) which contends that for higher order, transferable learning to occur, "flexible learning environments are required which permit the same items of knowledge to be presented and learned in a variety of different ways and for a variety of different purposes" (Spiro et al, 1991, p.24). The types of domain CFT is concerned with are those that can be considered ill-structured including medicine, history and literary interpretation, although it is argued that even structured domains with little variance in the scope for applying knowledge, for example mathematics, will possess a degree of "ill-structuredness" at more advanced levels (Spiro et al, 1991, p.26).

The instructional rationale for CFT is that because an individual cannot possess pre-formed knowledge for every possible situation, "knowledge that will have to be used in many ways is taught in many ways" (Spiro & Jehng, 1990, p. 171). Thus the goal is not "intact schema retrieval" but "situation-specific schema assembly" (Spiro et al, 1987; Spiro & Jehng, 1990). The instructional metaphor is that of the criss-crossed landscape. Based on an idea by Wittgenstein (1953), who saw knowledge domains as comparable to geographic landscapes, the proposal is that learning occurs through criss-crossing conceptual landscapes. Instruction should therefore involve "the provision of learning materials that channel multidimensional landscape explorations under the active initiative of the learner" (Spiro & Jehng, 1990, p.170). This requires subject materials to be presented as a non-linear text that allows multiple starting points and divergent paths, rather than in the linear form of presentation that traditional materials including textbooks typically adhere to. Consequently the medium that CFT advocates using for facilitating learning in ill-structured domains is hypertext, with "cognitive flexibility hypertexts" the term for educational hypertexts designed according to CFT principles (Spiro & Jehng, 1990; Spiro et al, 1991; Jacobson et al 1996). With this technological focus CFT, like anchored instruction, is an explicit example of the relationship between constructivist theory and the properties of current educational technologies.

2.2.5 SELF-AWARENESS AND REFLECTION

The emphasis placed upon increased autonomy, authentic tasks and contexts, collaborative working and multiple perspectives in constructivist environments has a wider purpose beyond supporting learning, and this is in helping learners to develop in their self-awareness and reflective ability. Honebein (1996) refers to this as "knowing how we know", which is manifested in "the student's ability to explain how or why they solved a problem in a certain way" (p. 12). Essentially this concerns metacognitive understanding, or the level of awareness an individual has about their own cognitive processes and abilities, and their subject-related knowledge (Flavell, 1985; 1987).

Within constructivist environments, the monitoring of knowledge development can be supported when learners are periodically required to critically analyse and justify the problem-solving and learning strategies used, the appropriateness of task solutions, and to consciously differentiate between what they feel they do and do not know (Grabinger & Dunlap, 1995; Jonassen, 1999). These forms of self-reflection can be facilitated in various ways. Collaboration with fellow learners is one option. Collaboration between tutor and student is another. Jonassen (1999) considers in detail the coaching role a tutor should assume in a constructivist environment, believing their most important function is to monitor and regulate the learners performance through: providing hints and tips on particular aspects of task completion; prompting appropriate kinds of thinking (i.e. to make inferences, summarise results, draw implications); and directing learners towards other information sources that may provide further clarification [16].

Both Jonassen (1999) and Grabinger & Dunlap (1995; Dunlap & Grabinger, 1996) also advocate the use of self-assessment and evaluation methods to allow learners to monitor and or periodically apply the knowledge they have developed, and determine for themselves the extent of their understanding. At a monitoring level of self-assessment, the latter suggest study diaries and simple checklists, while Jonassen proposes that

[16] This is indicative of the shift in responsibility for the tutor that in constructivist terms is most clearly addressed by cognitive apprenticeship theory (Brown et al, 1989; Collins et al 1989, 1991). Based on the traditional apprenticeship model, the effective tutor is seen as providing increasingly diminished coaching or guidance until the learner has mastered the subject under study and can function fully autonomously in the relevant domain.

technology-based tools (e.g. interactive simulations, hypermedia construction tools, expert systems) are valuable for enabling the application and testing of understanding [17].

Learners who possess a good level of metacognitive ability and are able to work independently, effectively managing their time and resources in order to achieve the desired outcomes, are said to be self-regulating (Brown, 1987; Pintrich, 1995). An important point about self-regulation is that it can be learned, and by supporting autonomy and reflection it is thought that constructivist environments can help students to become generally self-regulating, and therefore "flexible and creative problem solvers and life-long learners" (Dunlap & Grabinger, 1996, p. 80). The theme is the same one of knowledge and skills transfer consistently stressed by constructivists, except the emphasis is not on knowledge of a domain but of oneself as a learner [18].

2.2.6 AUTHENTIC ASSESSMENT

Constructivists believe the authentic nature of the tasks and contexts in which learners engage must also be extended to the forms of assessment used to determine their understanding. Several theorists (Jonassen, 1991; Grabinger & Dunlap, 1995; Reeves & Okey, 1996) have justified this rationale in terms of the disparity that would exist between trying to assess the type of learning constructivist environments are designed to support via conventional tests and assignments. It is argued that single criterion-referenced assessments are not sensitive enough to properly account either for the nature and transfer potential of the unique understanding an individual has arrived at, or for the

[17] In the context of this research, the NLE for the undergraduate chemistry class included simple progress checklists, interactive self-test questions, and an interactive molecular drawing tool to aid self-monitoring and assessment.

[18] Self-regulatory ability emerges as a key factor in the effectiveness of individual approaches to networked learning.

variance in understandings that would exist within a group of learners who have been working autonomously within authentic, multi-perspective contexts (Jonassen, 1991).

The resulting implications for constructivist environments are that assessment should, wherever appropriate, be based upon collaborative rather than individual effort, provide scope in time and resources to allow for the iterative development of solutions or answers, and have multiple possible solutions or answers (Shavelson & Baxter, 1992). In combination with the actual task to be undertaken, all are important factors in determining the extent to which an assessment can be considered authentic. Kerka (1995) defines authentic assessments as those that comprise meaningful learning activities in themselves, and measure learning by addressing the skills and abilities that will be required to perform real world tasks. Amongst the range of authentic assessment methods widely advocated are case study evaluations, experimental and design projects, research and report exercises, role-play, critical writing assignments, and portfolio development (Linn et al, 1991; Kerka, 1995; Reeves & Okey, 1996).

Aside from providing an indication of knowledge gained while also being a beneficial learning experience in itself, there is another argument for why learning and assessment within constructivist environments must be carefully aligned. Jonassen (1999) observes that learning within instructional contexts is largely assessment driven, ergo "learners develop fairly sophisticated strategies for identifying the expected performance and studying accordingly" (p. 236). Thus if the learner perceives the assessment to require a reproductive demonstration of knowledge, as they might if faced with a multiple choice test, then their learning may well be driven by a focus on memorisation. Jonassen notes that such strategies are inappropriate to successful learning within a constructivist environment, and so to increase the likelihood of effective learning occurring the assessment itself must be consistent with constructivist principles [19].

2.2.7 TECHNOLOGY SCAFFOLDING

The final major attribute of constructivist learning environments is the use of new and emerging technologies to provide an integrated platform for the entire learning environment (i.e. the environment is itself technological), or to provide tools that support specific aspects of learning activity. Each of the three main theoretical movements concerning learning in educational contexts have been interested in how the technology available to them can be harnessed for instructional purposes. For behaviourists, the focus was on using physical materials and later electromechanical tools that guided learning through a linear reading-response-reinforcement process. With the emergence of cognitivism, and subsequent arrival of the microcomputer, an initial focus on computerised forms of programmed instruction gave way to more sophisticated computer-assisted instruction (CAI) and intelligent tutoring systems, and system conceptualisations, that attempted to account for the individual in terms of their prior knowledge, individual characteristics and their responses whilst using the system, and the content they were presented with as result (Saettler, 1990; Cooper, 1993; Gillani, 2003). For constructivists, the main concern for the role of the computer is around the idea of "technology scaffolding" (Jonassen, 1999; Land & Hannafin, 2000).

Technology scaffolding can be thought of as the extent to which the tools and resources within a constructivist educational environment "provide opportunities for learners to amplify and extend cognitive capabilities" and "facilitate understanding that would be

[19] Evidence from educational research concerning how students approach learning in higher education, to be discussed in 2.4, has also demonstrated the relationship between task perception and learning strategy.

difficult, if not impossible, to otherwise support" (Land & Hannafin, 2000, p. 15). The idea of technology scaffolding derives from the concept of distributed cognition that originates from within cognitive science and social psychology, and which proposes that rather than cognition residing solely in the mind of the individual "people think in conjunction and partnership with others and with the help of culturally provided tools and implements" (Salomon, 1993, p. xiii). Bell & Winn (2000) use the term "artifacts" to describe computer-based devices that can extend or enhance human cognitive abilities, and so effectively "make individuals smarter and more productive while using them" (p. 130). Amongst the types of artifact they identify are databases for extending the capacity of human memory, and interactive simulations that facilitate experimentation by allowing variables to be manipulated and the effects observed.

Current technologies commonly used in constructivist environments include hypertext, multimedia, the World Wide Web, and channels of asynchronous and synchronous computer mediated discussion. Technologies emerging in the last decade include virtual reality applications, multi-user domains, interactive modelling tools (Hannafin & Land, 1997; Jonassen, 1999; Weller, 2002) and the now-emerging social software tools including Blogs and Wikis. Many constructivists refer to the potential of a specific technological resource to support a particular aspect of learning as the "affordance" of that technology (Ryder & Wilson, 1996; Bell & Winn, 2000).

2.2.8 LIMITATIONS OF CONSTRUCTIVIST LEARNING THEORY

Despite the extent to which constructivism dominates current thinking about learning and how this should be facilitated within instructional contexts, constructivist theory can be seen as limited in several key respects. Initial criticisms from the instructional design theory (IDT) fraternity focused, justifiably, on the constructivist argument that since learning was an interpretative process there could be no single 'true' perspective or understanding for any event or concept. This was rejected by many leading instructional designers who fully acknowledged the importance of supporting learners in developing a critical understanding of a domain, but also argued for the importance of shared perspectives and beliefs as the building blocks for effective learning, and the existence of commonly accepted and agreed upon facts, principles and procedures at the core of any domain (Merrill, 1992; Reigeluth, 1992). Attention was also drawn early on to the lack of guidance constructivist theories of learning and instruction provided to educators who may want to facilitate effective learning through applying constructivist principles, including the contexts in which a constructivist approach may not prove useful, the entry knowledge and characteristics of students, the possible detrimental effects of increased student autonomy, the form and role of learning objectives, the organisation of content, and how to determine learning effectiveness (Dick, 1997).

Many of these issues remain contentious topics of debate, although the intervening years since constructivism first came to prominence has seen most of them addressed to some extent. The terms "moderate constructivist" and "radical constructivist" are used to distinguish between those constructivist theorists who recognise that some knowledge can be thought of as existing externally to the learner in the form of the accepted facts and principles within a domain, and those who contend that all knowledge is the result of a personal interpretative process and so can only ever be unique to the individual (Molenda, 1997). For those who occupy what might be referred to as a moderate constructivist position, there is a recognition that for some types of learning, including the memorisation of basic facts and learning how to use clear procedures, the kind of systematic instruction associated with IDT will often be more appropriate and effective (Hannafin, 1992; Lebow, 1993; Jonassen, 1999).

In addition, there are those who have come to take the view that the ideas of constructivist learning theory and prescriptive rigour of instructional design theory might usefully complement one another in facilitating effective learning within educational contexts. Lebow (1993) proposed the nature of this relationship could rest on a series of constructivist principles to inform the instructional design process, including embedding the reasons for learning within learning activities, and strengthening intentional learning tendencies by encouraging the strategic exploration of errors. For Lin et al (1996), the concern was with tailoring the central tenets of the instructional design process – such as identifying objectives, assessing prior knowledge and skills, and specifying content and instructional strategies – to developing "learning communities" within the classroom. Furthermore Biggs (1996, 2003) has written about the possibilities of enhancing teaching through "constructive alignment". This essentially involves using constructivist ideals as a framework for informing all instructional design decisions, and then using the resulting learning objectives to systematically match teaching and assessment methods in a manner comparable to IDT.

Quite separately, over the years an increasing number of constructivist models and frameworks have emerged that are more prescriptive in their descriptions of how to facilitate learning than earlier constructivist theory was, and offer more in the way of practical guidance and recommendations. This includes several of the frameworks discussed in the preceding overview of constructivist learning environments (e.g. Grabinger & Dunlap, 1995; Savery & Duffy, 1996; Hannafin et al, 1997). Similarly, within the IDT field, Van Merrienboer and colleagues (1997, et al 2002) have produced the Four Component Instructional Design model, which provides comprehensive prescriptive guidance on designing problem-based learning contexts, while Merrill (2002) has convincingly illustrated how the 'first principles of instruction' (e.g. learner engagement in real-world problems, existing knowledge as the basis for new learning, diminishing coaching, using knowledge in varied contexts) are fundamentally the same across the major theoretical perspectives.

Criticisms continue to be levelled at the lack of detail constructivist theories provide on the design rather than desired content of educational interventions, materials and resources, including the appropriateness of different constructivist strategies for particular contexts and purposes, striking a balance between supporting individual autonomy while ensuring that the curriculum is successfully addressed, and how to assess the learning outcomes of authentic coursework so that comparable qualities in understanding are equally recognised (e.g. Allessi & Trollip, 2001; Weller, 2002).

However perhaps the most serious criticism that can be made of constructivist learning theory, certainly in relation to this research, is that it is still to properly address the role and influence of the learner. This is evident from the propositions it puts forward concerning the various benefits of increased student autonomy, collaboration, exposure to multiple perspectives, and authentic contexts, which almost without exception seem to hold the implicit belief that the individual will always interact with the learning environment in a manner that is conducive to the kind of effective, learner-centered experience constructivist instructional principles are intended to facilitate. Goodyear (1999) has addressed what he refers to as the "decline of the compliant learner", and observes how societal and educational developments mean it has long been unreasonable to assume that students will interact with educational environments in the ways their tutors intend or expect (p. 3). In relation to constructivist learning theory, what might be more appropriately termed 'the myth of the complaint learner' is particularly problematic, as while constructivist theory continues to describe how to design engaging and effective educational environments, empirical research is increasingly showing (as will become apparent) that many learners often make poor use of the resources placed at their disposal within student-centered contexts. It is also ironic in that a movement founded on the belief that learning and understanding is an interpretative process shaped by individual perceptions, experiences and interactions has made little attempt to account for how the agency and characteristics of the individual themselves might contribute towards how effectively they learn in practice. That this is an area in which constructivist theory is lacking has not gone unnoticed, although to date only a few leading constructivists have acknowledged that the learner and related issue of learner 'compliance' need addressing within constructivism, or recognised that students will not necessarily interact with constructivist environments effectively (e.g. Salomon, 1986; Land & Hannafin, 2000; Xun & Land, 2004). Our lack of understanding about what the student might contribute to their interaction with learner-centred environments is also being recognised out with the confines of constructivist learning theory (Merill, 2000; Palloff & Pratt, 2003; Bowles, 2004).

2.3 AFFORDANCES OF NETWORKED LEARNING ENVIRONMENTS

2.3.1 THE CONCEPT OF AFFORDANCES

The concept of affordances originates from the work of the ecological psychologist James Gibson (1977; 1979), and his theory of visual perception. Gibson defined the term "affordance" to describe the relationship that exists between an individual and the opportunities for action they perceive within the properties of environmental objects. For example, "if an object that rests on the ground has a surface that is itself sufficiently rigid, level, flat, and extended, and if this surface is raised approximately at the height of the knees of the human biped, then it affords sitting-on" (1977, p. 68).

If manufactured we would refer to such an object as a chair, although the description could equally apply to a naturally occurring ledge. The point is that the perceivable, coexisting properties of the object "combine to yield a higher-order property for the human observer" (1977, p. 68). An example relevant to human communication and cognition would be a hand-held tool that leaves a visible trace when applied to paper. We call this a pen or pencil, and through affording trace-making it in turn affords us the opportunity to create visual depictions and record language (Gibson, 1979, p. 134).

In elaborating upon the concept Gibson (1977; 1979) is careful to stress that although the affordances of any particular object are inherent in the properties of that object, and in this respect are constant, they are relative to the needs of the individual. Therefore whilst a pen affords the opportunity for written communication, the object itself holds no immediate significance for an individual who perceives its affordance but has no present need to write. This exemplifies the emergent nature of affordances, which cuts across the objective-subjective dichotomy by being both a physical fact of the environment and a psychical fact of individual cognitive behaviour. Gibson (1979) states of this relationship that "The observer may or may not perceive or attend to the affordance, according to his needs, but the affordance, being invariant, is always there to be perceived...The object offers what it does because it is what it is" (1979, p. 139).

Two critical points about the affordances of objects is that they can be both positive and negative, and may also be misinterpreted. In relation to the former, a knife affords cutting if wielded appropriately but affords being cut if wielded inappropriately. As regards the latter, the misinterpretation of affordances can occur when the environment contains misinformation about the object. Gibson (1977; 1979) uses the example of quicksand, which may appear solid on the surface and seem to afford the possibility to walk from one point to another. Whilst fairly abstract, these illustrations are useful for appreciating two important propositions within the original theory of affordances.

In recent years, the basic concept of affordances as a construct for describing the relationship between people and objects has increasingly been adopted by researchers seeking to explain the potential of technology to support aspects of human endeavour. Gaver (1992) was the first to do so, discussing the affordances of media spaces, or "computer-controllable networks of audio and video equipment" (p. 17), to enable synchronous collaboration amongst the geographically dispersed. Those working within the field of educational technology have been quick to follow suit, and the concept has become increasingly prevalent in the literature. This is reflected in the number of papers that have explicitly addressed the original concept in relation to learning via multimedia (CTGV, 1993; Jonassen et al, 1994; Laurillard et al, 2000), asynchronous communication (Crook, 1997a; McAteer et al, 1997; Tolmie et al, 2000), the Internet (Ryder & Wilson, 1996), and intelligent tutoring environments (Akhras & Self, 2002; Wible et al, 2003). That the term 'affordance' is now common currency when discussing educational technology is apparent within those papers that simply acknowledge the basic idea (e.g. Allen et al, 1996; Hannafin & Land, 1997; Saye & Brush, 1999; Sullivan & Czigler, 2002; Volet & Wosnitza, 2004).

In the context of educational technology, we think of an affordance as being the opportunity for extended learner capabilities that can be perceived in the properties of a specific technology or media (Ryder & Wilson, 1996). NLEs are autonomously accessible web-based resources that combine hypertext course materials with multimedia information and tools, and channels for computer-mediated communication. The contemporary literature on learning, and learning with technology, makes many claims about the affordances inherent within NLEs and their constituent elements.

2.3.2 NETWORKED ENVIRONMENTS AND LEARNING

The convergence of a rich range of tools and materials within a single point of web access that characterises NLEs can be described as facilitating "one stop shopping" learning (Hill, 2000). Traditionally the learner consults materials and people at different points in space and time, including the lecture theatre for basic course content, library for further reading, classroom for discussion, or a computer laboratory for software applications. Through utilising the web as a delivery platform, NLEs are distinct for enabling access to tools, materials and people at the same point in space and time.

The literature claims two main advantages to this. The first concerns the asynchronicity that NLEs share with the kind of communication tools they often feature. This allows for "learner-paced learning that can take place anytime of the day or night" (Romiszowski, 1997a, p. 213), and in which "material can be reviewed for missed concepts as many times as the student would like" (Berge et al, 2000, p. 33). As the student is empowered with deciding when to learn, they are afforded the opportunity to learn when they feel most motivated, at their optimum rate of learning, at times most conducive to sustained periods of learning, and can also undertake studying from various locations. Their autonomous nature means networked environments are also ideally suited to the practice of 'just-in-time' learning. The rationale is "that the person who requires a new skill should learn it at the time and never before", as this is when the need for what is being learned will make the most sense and knowledge is most effectively appropriated (Romiszowski, 1997b, p. 27). Although typically discussed in relation to lifelong and open forms of networked learning (Goodyear & Steeples, 1992), the concept can be seen as important in any instructional or educational context.

If the high level of student control inherent in NLEs marks their potential as effective constructivist learning environments, then this is further consolidated by the second major advantage associated with them. Miller & Miller (2000) describe the convergence of hypertext, multimedia, and communication facilities via the web as constituting a "unique environment for learning", with this uniqueness attributed to the way in which the educational potential, or affordances, of each constituent element interrelates to support a full range of constructivist learning activity that would be beyond the scope of any single one (p. 157-158). If the claims made for the constituent elements of networked environments are accepted, then this convergence of technologies is effectively a convergence of affordances, and in theory any learner interacting with a NLE could be expected to benefit in their understanding from the ways in which, for example, multimedia and asynchronous communication support different aspects of the knowledge construction process (Bostock, 1998; Salomon & Almog, 1998; Miller & Miller, 2000). All of the ways in which the features of NLEs are believed to support learning are either consistent with or have a basis in constructivist theory and principles, and in most instances there is at least some empirical evidence to support the claims made regarding the affordances of NLEs.

2.3.3 HYPERTEXT AND LEARNING

Nelson (1974, 1981) defined 'hypertext' as non-sequentially organised electronic text allowing multiple paths of exploration, immediate access to the information stored within, and possible editing by the reader [20]. Hypertext is characterised by a node and link structure. Nodes comprise windows or pages containing text, graphics and other types of information, whilst links are the active words or pictures that allow access to the nodes. Due to this flexibility, hypertext is open to any model the designer wishes to impose (McAleese & Green, 1990; Jonassen & Mandel, 1990). Possible models for educational hypertexts include task-related structures, hierarchical structures based on content relationships, and semantic structures based on the organisation of knowledge within the mind of a subject expert (Jonassen & Grabinger, 1990). It was with the effects of learning via such semantically structured hypertext that most early research was concerned (Jonassen, 1989; 1990; Jonassen & Wang, 1993; Park & Hannafin, 1994). The main contention was that because in cognitive terms learning is the restructuring and development of semantic knowledge structures (the theory of Rumelhart & Norman, 1978 was a key influence in this thinking) and hypertext is basically a semantic system, then "mapping the semantic network of an expert...onto the structure of a hypertext will contribute to the development of the learners' knowledge structures while using the hypertext to learn" (Jonassen & Wang, 1993, p. 2) [21].

At a general level, the claim made for the educational value of hypertext rests on the increased learner control that studying via hypertext course material involves, as within the navigational parameters of the hypertext it is the learner rather than the instructor

[20] The technology of hypertext was originally conceptualised by Vannevar Bush (1945) who envisioned a future device termed a "memex" for organising and exploring information based on associations rather than indexing.
[21] Although some theorists were quick to question the extent to which the node and link organisation of a hypertext could possibly replicate the complexity of human semantic knowledge (Whalley, 1992; Dillon et al, 1993).

who determines the order and depth in which to explore content. It is proposed this empowerment in turn enables, or affords, the opportunity for more active knowledge appropriation on the part of the learner who can proceed at a pace reflecting their own ability level and personal knowledge requirements (Jonassen, 1989; Jonassen & Grabinger, 1992; Stemler, 1997). It is because hypertext allows the learner to interpret information and choose paths of enquiry in this way that it is claimed "hypertext is necessarily a constructivist environment" (Jonassen, 1992b, p. 394). The desired outcome is for the learner to develop a critical, deep understanding of a domain.

However, research has been less consistent in supporting this claim empirically than proponents of the medium have in supporting it theoretically. Investigations into educational hypertext as a single medium, although now become less common, have mainly been experimental studies involving comparison against traditional media or the effects of different hypertext structures (Chen & Rada, 1996; Dillon & Gabbard, 1998)[22]. Most studies concerning the former, including major meta-analyses, report "no significant difference' in the quality of learning outcomes between hypertext and paper-based course material (Becker & Dwyer, 1994; Dillon & Gabbard, 1998). Although often interpreted negatively, this actually indicates that hypertext is at least as effective as the traditional print medium (McKnight et al, 1992). There is also some evidence to suggest that even when no significant difference in outcomes is found, students value hypertext as a more interesting medium to learn from (Cockerton & Shimell, 1997). This supports the claim that the learner controlled, exploratory nature of hypertext can have a valuable motivating influence upon learning (Jonassen, 1989) [23].

[22] A third strand of research concerns the effects of learning style upon learning via hypertext, discussed in 2.5.

[23] Although this may equally be interpreted in terms of the novelty effect that will be discussed shortly.

Comparative studies involving traditional lecture-based instruction have been more encouraging on the educational potential of hypertext. Najjar (1996) analysed over two hundred studies, and found achievement was generally higher for the hypertext than lecture-based groups. Additionally, the early landmark study by Beeman et al (1987) observed an increase in grades from the previous year when instruction was lecture-based, which was corroborated by a positive correlation between a high level of hypertext use and high grade achievement. The learners themselves also perceived the hypertext resources as being conducive to the development of a better, more pluralistic understanding than they would ordinarily expect to develop, as did the respective tutors who believed this was reflected during traditional seminar discussions [24]. However, the meta-analysis by Dillon & Gabbard (1998) found only congruent levels of knowledge.

On the effects of different hypertext structures, several experiments have required learners to interact either with a semantically structured hypertext designed around the semantic organisation of a domain, or more linear hypertexts that could be read like conventional print (Stanton, 1991; Brown; 1997; Shapiro, 1998). Shapiro found that a semantic hypertext was more conducive to conceptual understanding than a linear one. This was attributed to the non-linear hypertext requiring more comprehension effort, and is consistent with Stanton who attributed an improved capacity for knowledge transfer to the active exploration supported under non-linear conditions.

As previously discussed, promoting active engagement with semantically complex hypertext is central to Cognitive Flexibility Theory (Spiro et al, 1987, 1991; Spiro & Jehng, 1990; Jacobson & Spiro, 1995; Jacobson et al, 1996). Focused on the assembly rather than reproduction of relevant knowledge whilst utilising educational hypertexts,

[24] Similar perceptions are to be found in the empirical research relating specifically to the educational value of NLEs.

features of a cognitive flexibility hypertext might include a diverse range of case materials associated with a domain, thematic and conceptual links across materials, and commentaries describing the application of knowledge within the case or scenario currently being studied (Jacobson & Spiro, 1991, Jacobson et al, 1996) [25]. Empirical research into learning via hypertexts consistent with CFT principles has demonstrated their effectiveness, reporting a strong relationship between the proliferation of CFT-based features within a hypertext and the transferability of knowledge (Jacobson & Spiro, 1995; Jacobson et al, 1996, Fitzgerald et al, 1997). The study by Fitzgerald et al (Ibid) investigated how education students used and perceived using a CFT hypertext resource, and found "a significant change in their understanding and synthesis of multiple perspectives and team roles" (p. 74). As CFT becomes more prominent, it is expected to increasingly influence the design of NLEs that harness the potential of the web to link to additional sources of domain material (Jonassen et al, 1997).

On reflection, it is difficult to arrive at definite conclusions regarding the benefits of hypertext due to the varied findings of the research to date. This has been attributed to a number of things including inconsistency in experimental design, poor consideration of the instructional and personal factors that might be influential, and focusing on how a hypertext design was expected to support learning rather than the cognitive processes actually taking place (Jacobson & Spiro, 1995; Chen & Rada, 1996; Dillon & Gabbard, 1998). However when the general properties of hypertext as described in the constructivist literature are considered, then clearly hypertext at least has the potential to allow learners an increased level of freedom and responsibility for their learning. Depending upon the content and nature of the material presented, and assuming the

[25] CFT signalled a move away from the logic of designing hypertext based upon modelling the semantic knowledge structure of a domain expert. Although such a model may partially inform the structure of a cognitive flexibility hypertext, the emphasis is on providing multifarious ways of exploring a domain (Jacobson et al, 1996). This counters the valid criticism that viewing hypertext as a means for replicating the knowledge structure of an expert within the mind of the learner, as was the original focus of educational hypertext research, arguably represents a variation on the transfer model of instruction to which constructivism is so fervently opposed (Whalley, 1992).

learner interacts with it effectively, this process of domain exploration could become an effective learning experience, and there is at least some evidence to suggest that it does.

2.3.4 MULTIMEDIA AND LEARNING

Although the term 'multimedia' has been used within education since the middle of the last century, technological advances have led to educational multimedia being generally thought of as the integration of text, pictures, graphics, animations, video and sound within a computer-based environment (Najjar, 1996). Hypertext-based applications that include audio or visual information are one type of educational multimedia environment, and the kind that has attracted the most interest due to the ease with which hypertext can accommodate additional forms of media for simultaneous presentation at the computer screen (CTGV, 1993a; Tergan, 1997, Miller & Miller 2000). The theoretical and empirical work on multimedia reveals what it might be expected to afford learners as part of a networked learning environment, and in relation to this issue three threads of research are particularly relevant. These are: the role of multimedia in contributing to the authenticity of learning environments; experimental research into the effects of supportive multimedia; and the phenomena of cognitive offloading.

2.3.4.1 THE AUTHENTICITY OF LEARNING ENVIRONMENTS

Concerning the extent to which instructional environments are likely to prepare the learner for the 'real world', the notion of authenticity underpins key constructivist beliefs and ideas on learning activities, assessments, and instructional contexts (Bednar et al, 1992; Honebein et al, 1993; Reeves & Okey, 1996; Jonassen, 1999). It is in relation to this last issue that multimedia is of most interest to constructivists, some of whom prefer to describe multimedia as "integrated media" to better reflect a mindful approach to integrating media formats rather than a "more modalities the better" philosophy (CTGV, 1993a, p. 71). This mindful use is concerned with presenting information and phenomena in a form resembling that in which they are actually encountered in order to aid the transfer of knowledge to new situations both real and realistic (CTGV, 1993a; Honebein et al, 1993; Jonassen et al, 1994).

The previously discussed constructivist strategy of anchored instruction is of note here (CTGV, 1990; 1992; 1993b). Probably the hallmark constructivist view on the authenticating potential of multimedia, the instructional use of video-based multimedia in anchored instruction is specifically justified through alignment with Gibson's (1977; 1979) original concept of affordances. The contention is that whilst presenting mathematics instruction, for example, as text-based word problems affords only the opportunity for performing decontextualised computations, embedding the instruction within a video narrative affords the opportunity for learners to identify relevant information, generate sub-goals, test strategies, collaborate, and so develop knowledge and skills that can very easily be applied to novel situations (CTGV 1992; 1993b).

Although an interactive videodisk is quite different to a NLE, the literature describes numerous resources that are consistent with the basic philosophy of anchored instruction whilst typifying how multimedia can contribute to the authenticity of hypertext-based environments. Casey (1996) discusses an environment that attempted to integrate the cognitive apprenticeship model within a hypertext-based tutorial for helping weather forecasters learn to interpret a new form of radar. The rationale was to support learning in the 'on the job' manner to which the forecasters were accustomed, and involved presenting a typical forecasting scenario along with multimedia options for exploring the subject matter. Learners could view short video narratives providing contextual information, access text explaining relevant analysis heuristics, and examine data in abstract graphical forms alongside conventional satellite imagery. The students were therefore provided with all the information that is available when training within the professional environment, but were freed from the necessity of having to be situated within the actual environment in order to develop the new knowledge required.

A similar approach was taken in the environment described by Hannafin et al (1997), which students used to learn about the principles of physics within the design of a rollercoaster. This included interactive demonstrations of the concepts under study, explanations of those concepts from relevant perspectives (i.e. physicist, roller coaster designer), and a tool for plotting and viewing the effects of learner-selected parameters.

As a final illustration, the purpose of Honebein et al's (1993) resource was to simulate exploring and researching the use of a biotechnology building. This was facilitated in part by an interactive diagram that depicted the outer façade, and contained links for each floor that led to layout diagrams, descriptions and photographs for each room. The research element was enabled through access to transcripts of interviews conducted with the inhabitants, architects and builders, and reproductions of secondary source documents including official documents. Echoing the claim that constructivists make regarding the authenticating potential of multimedia, Honebein et al (1993) explained that as "the environment provides a level of complexity and information representative of the actual setting...learners are able to apply the same problem solving skills in accomplishing the tasks as if they had been in the actual environment [and] are more readily able to transfer those skills to an actual environment" (p. 102-3).

Unfortunately the constructivist literature offers relatively little empirical support for the claims it makes about authentic multimedia and learning. Thus a critic taking a harsh stance might observe that Honebein (1996) justifies the rationale for using multiple representations through reference to the truism "a picture is worth a thousand words" (p. 21) rather than any empirical evidence [26]. However, there is an established tradition of experimental research into the effects of multimedia upon learning, and it offers some valuable insights into the educational potential of multimedia in NLEs.

2.3.4.2 EXPERIMENTAL RESEARCH INTO SUPPORTIVE MULTIMEDIA

A common use of multimedia within NLEs is as "supportive multimedia", which is the meaningful combination of visual representations with text so that one medium supports, relates to, or extends the information presented in the other (Najjar, 1998, p. 313). Numerous cognitive experiments have addressed the effects of supportive multimedia upon learning, and the main reference framework for much of this work is the dual-coding theory (DCT) of Paivio (1971, 1986; Clark & Paivio, 1991).

The central premise of DCT is that long-term memory contains two independent sub-systems for processing different types of information. The verbal system processes information presented in a verbal form, such as text or audio, whilst the non-verbal, or imaginal system, processes images for shapes and objects, but also non-linguistic sounds and visceral sensations. The representations within either system are thought to be modality-specific and retain characteristics of the sensory-motor events of their perception. Therefore whilst the 'logogen' for the word 'book' would include the

[26] The anchored instruction theorists conducted an evaluation of learning outcomes for their Jasper series (CTGV, 1992). In comparison with class-based instruction equivalent levels of conceptual understanding were found, although the students who had interacted with the interactive environment did perform better on a problem-solving post-test. Although there are other examples, studies on 'authentic' multimedia and knowledge transfer appear rare.

verbal label used to denote the object within the language of the perceiver, the 'imagen' for the object 'book' would have visual and tactual properties similar to the actual object (Clark & Paivio, 1991, p. 151-2).

DCT views long-term memory as an associative network linking imagens and logogens within and across the verbal and imaginal systems. Although several types of connection exist, the basic idea is that information presented in both verbal and visual formats, and which can be referentially processed, has an additive effect that results in better learning than would occur via verbal or visual information alone, and better recall as the learner has two reference points for facilitating retrieval – with activation of the visual activating the verbal, and vice versa (Paivio, 1986; Clark & Paivio, 1991).

Early dual coding experiments involved traditional media such as print (Clark & Paivio, 1991; Burton et al, 1995; Najjar, 1995). However a growing number of studies have addressed dual coding in relation to computer-based multimedia, with Richard Mayer and colleagues the most prolific in this area. Their initial investigations required students with comparable knowledge to read passages explaining the operation of simple mechanical systems including pumps and breaks. It was found that those who read a version of the text accompanied by complementary illustrations performed better on a transfer test requiring the recall and demonstration of understanding, which was taken as tentative evidence that referential processing of verbal and visual information described in dual coding theory had occurred (Mayer, 1989; Mayer & Gallini, 1990).

Further experimentation by Mayer & Anderson (1991, 1992) provided more elaborate supporting evidence in relation to what they termed the "contiguity principle". The basic proposition, that words and pictures presented together rather than apart in space and time are most effective for learning, was tested in comparisons of words-before pictures, words-after-pictures, words alone, and words-with-pictures conditions. The results of problem-solving tests consistently demonstrated that studying contiguous multimedia enabled a better performance than non-contiguous multimedia did.

Other researchers concur that complimentary, simultaneously-presented verbal and visual media are more effective for learning and recall than single media (Large et al, 1994, 1995; Chuang, 1999; Dubois & Vial, 2000; Michas & Berry, 2000). This is not to say that support for a dual-coding hypothesis is unopposed. Information processing theories that view long-term memory as a unitary structure based on semantic relationships, as propositional network theory does, would contend that knowledge of visual objects is constructed, and in recall is reconstructed, from verbal codes corresponding to perceived characteristics (Anderson, 1990, 1995). There is empirical evidence that different types of visual information, e.g. diagrams versus animation, are more effective in conjunction with different types of verbal media for different purposes (Najjar, 1996, 1998). These issues aside, the literature does recognise DCT as representing the main, and a reasonable, explanation for understanding the effects of supportive multimedia (Burton et al, 1995; Najjar, 1995; Mayer, 2001).

2.3.4.3 MULTIMEDIA AND COGNITIVE OFFLOADING

In the constructivist literature the enhancement of learning through interacting with different tools and media types is discussed in terms of "distributed cognition" (Bell & Winn, 2000). Although sometimes also referred to as cognitive or computational offloading (Jonassen, 1994), the concept actually originates from within cognitive science research into the effects of interacting with visual multimedia. In this context, cognitive offloading can be defined as "the extent to which different external representations reduce the amount of cognitive effort to solve informationally equivalent problems" (Scaife & Rogers, 1996, p. 188) [27]. This refers to the efficiency with which a graphical representation enables more direct comprehension of the phenomena being depicted in comparison with a text-based description of it. From a constructivist perspective this is a critical issue, as it means the learner is able to more immediately appropriate and apply knowledge as they interact with the multimedia components of their learning environment (Perkins, 1993; Jonassen et al, 1994, 1996).

Several cognitive research studies have contrasted the cognitive offloading potential of graphics versus text, and also between different forms of graphical representation. Whilst comprehensive reviews are available (e.g. Cheng et al, 2001), an overview of exemplar studies provides a useful illustration of the kinds of cognitive offloading effects that could be associated with the supportive multimedia often featured in NLEs.

Static diagrams and text were compared in major studies by Larkin & Simon (1987) and Bauer & Johnson-Laird (1993). The latter compared text with diagrams in relation to how students comprehended and solved an electronic circuitry problem. For those exposed to the diagrams, it was concluded "in their mind's eye they can imagine moving the pieces or switches...bypassing the construction of the meanings of verbal premises and manipulating visual images appears to reduce the load on working memory and to speed the process of inference" (Bauer & Johnson-Laird, 1993, p. 373).

The cognitive offloading effect of graphical representations may be enhanced through animation. Schnotz & Grzondziel (1996) propose that this is because "static pictures

[27] Within cognitive science research the generally preferred term is computational offloading, although to remain consistent with the constructivist literature the term cognitive offloading is used as standard.

convey only structure information. Animated pictures, on the contrary, also display the transformation of structures in time. Thus, they can show the dynamics of the respective subject matter" (p. 8). Two possible outcomes are thought to result from this. The first is the construction of a "dynamic mental model" that the learner can run as a mental simulation, and the second is enabling the visualisation of dynamic processes for those learners that would ordinarily be unable to do so. In an experiment contrasting comprehension of global time zone and circumnavigation issues with static versus animated pictures, Schnotz & Grzondziel (Ibid) found that on a test designed to assess the quality of mental models "subjects who had learned with animated pictures performed highly significantly better than subjects who had learned with static pictures" (1996, p. 17). Finally, in a study that is particularly relevant to one of case studies undertaken for this research, Hyde et al (1996) evaluated the effectiveness of an interactive molecular modelling tool in helping learners visualise three-dimensional chemical structures. Overall mastery measured through self-assessment questions was high, averaging in excess of eighty percent. Subjective perceptions indicated that sixty percent felt the ability to rotate the models helped them learn more, while almost all felt that interaction similar the models would help them in other chemistry subjects.

If the theoretical and empirical case for cognitive offloading is accepted, then from a theoretical perspective at least the potential educational affordances of supportive visual multimedia can be seen as three-fold. Specifically, it might be expected to enhance understanding through contributing to the real-world authenticity of learning environments, facilitating the referential processing of verbal and visual information, and by enabling a more direct comprehension of information and phenomena.

2.3.5 ASYNCHRONOUS COMMUNICATION AND LEARNING

Within networked learning environments, student-student and student-tutor discussion is often supported through asynchronous computer-mediated communication facilities. Commonly termed 'computer conferencing', this involves "communication by written messages, stored in a central location and accessible by a group of users at any time" (Mason, 1994, p. 12), with messages typically organised based on subject and order of posting. At a broader level of definition, asynchronous communication also includes e-mail to support one-to-one-or-many communication (Newman, 1990; Crook, 1994).

The salient feature of computer conferencing and e-mail as mediums for discussion, and which defines their education potential, is that for the duration of a dialogue "members of the class typically are not present at the same time or at the same place" (Hiltz, 1994, p.6). While this offers an obvious solution for enabling communication amongst the geographically and temporally dispersed, the main educational advantage lies in the increased opportunities for reflection. As Henri (1991) explains, "the learner can take the time to examine a particular comment...[and] analyse and understand them with the same precision as that applied to the analysis of print" (p. 148). The promise this holds for learning is widely acknowledged as being a greater scope for apprehending and formulating views than exists in face-to-face seminars and other synchronous contexts, and which may therefore result in a greater depth of discussion and understanding (e.g. Mason & Kaye, 1989; Harasim, 1990; Mason, 1994; McConnell, 2000).

It is also thought that asynchronous CMC has a "democratising influence" which ensures it is a more egalitarian platform for discussion (Steeples et al, 1994). This has been attributed to the "relative anonymity" inherent within it, and which curtails the possibility of individuals being discriminated against on the basis of physicality, fluency in a secondary language, or being amongst the less "loquacious" members of a group (Mason, 1994, p. 21). A related factor is that asynchronous communication can "reduce competition for airtime" amongst learners, as "there is no concern that time restrictions or turn taking will limit expression or opportunities to speak...and each user can participate to the degree that he or she wishes" (Harasim, 1990, p. 47).

In principal then, the affordances of asynchronous discussion facilities exist on a number of levels. The first is in supporting the social collaboration and reflection endorsed by constructivism. Beyond this there is also a reasonable argument for supposing an increased quality of discussion may occur, while positive discrimination against those who could be disadvantaged in face-to-face contexts is also a possibility. In considering the empirical evidence that might provide support for these assumptions, two main threads of research are deemed relevant: that which evaluates the quality of online discussion, and that relating to student participation in and perceptions of it.

A vast amount of research has attempted to assess the quality of discussion that occurs via asynchronous communication. This includes studies that have compared face-to-face with online discussion, used some form of content analysis to determine the quality or depth of asynchronous discussions, and considered tutor perceptions of student contributions. Although specific results vary, there is certainly much evidence to suggest that asynchronous communication can sustain effective discussion.

In addressing the first issue, the study reported by Newman et al (1996, 1997) took a rigorous approach to contrasting face-to-face and asynchronous seminars. An exhaustive set of indicators was developed for determining, through analysis of seminar transcripts or online contributions, the extent to which critical thinking as evidenced by in-depth understanding, reasoning and evaluation had taken place. In the undergraduate Information Management cohort studied, critical thinking was seen to have occurred both face-to-face and online. Against their initial assumption, it was found that "the computer conference discussions showed a significantly deeper overall critical thinking ratio than the face-to-face seminars" (Newman et al 1996, p. 71). However, there were differences regarding the attributes of critical thinking supported within each context. Students participating in online discussion were more likely to refer to outside material, link together ideas, and on average made more important statements than those who participated in face-to-face seminars. Conversely the latter were more likely to come up with new ideas, and produced more statements on average. It is suggested these findings reflected the properties of each medium. Thus the asynchronicity of computer conferencing, enabling increased reflection and access to all previous contributions, "encouraged a worthier, more considered style of interaction, leading to more important statements, and making it easier to link ideas together" (Newman et al, 1997, p. 493).

Newman et al's findings are representative of similar comparative studies which have concluded that computer conferencing is at least as effective as face-to-face discussion, results in a higher ratio of relevant and more elaborate contributions, but is generally characterised by less contributions overall and of a more spontaneous, left-of-field nature (Bordia, 1997; Adrianson & Hjelmquist, 1999; Ocker & Yaverbaum, 1999). Further evidence relating to the quality of asynchronous discussion is found within research involving non-comparative content analysis. Hara et al (2000) applied an established online discussion content analysis model to the contributions within a supplementary conference facility for a lecture-based course. It was noted that "while students tended to post just the one required comment per week in the conference, their messages were lengthy, cognitively deep, [and] embedded with peer references" (p. 115). Similarly Martunnen (1997) looked at the levels of argumentation and counter-argumentation within e-mail supported discussion, and concluded that the asynchronous nature of the medium had effectively supported the development of debating skills.

While these studies indicate that effective discussion is possible through asynchronous communication, they offer little insight into the more experiential aspects of participating in it. One obvious issue is the extent to which students themselves experience it as being more egalitarian than face-to-face debate. Research suggests some do, and a number of studies provide examples of asynchronous communication 'giving voice' to normally reserved students through granting greater anonymity and more time to compose their thoughts (Duffy et al, 1995; Light et al, 1997; Wilson & Whitelock, 1998). Yet there is also evidence to indicate that some learners can find asynchronous communication oppressive, feeling intimidated at the thought of their contributions being visible for scrutiny, in addition to their finality once posted (Naidu et al, 1995; Light et al, 1997). As one student in the Light et al study commented "the thought of trying to express an opinion on something you don't know much about anyway can be a bit daunting when the whole world can see you" (Ibid, p. 231-232).

Furthermore, the literature indicates that many students dislike the asynchronicity of asynchronous discussion, finding it more constraining and frustrating than face-to-face communication (Webb et al, 1994; Naidu et al, 1995; Ocker & Yaverbaum, 1999; Seale & Cann, 2000). Invariably this is attributed to a lack of social cues, length of time it takes to receive responses and reach a consensus, and simply feeling that they can communicate better vocally. Often these negative associations result in less active, or minimally required, participation in asynchronous discussion, although the extent to which individuals find asynchronous communication oppressive or frustrating may be symptomatic of a larger obstacle. In a later investigation, Light et al (2000) found that many students were uncertain about their role as a participant in online debate. Perceiving the medium as markedly different from traditional seminars, those interviewed reported being "confused over what was expected" of them, which was often linked to a "reluctance to be the first person to contribute" (p. 88). As a result, initial postings were essay-like and only became more conversational over time. Despite well-prepared contributions being a benefit of the medium, the important point here is that learners were unable at the outset to orientate themselves towards participating in the discussion. They essentially lacked the mindset for communicating in this way - a factor widely acknowledged as critical to the effectiveness of asynchronous discussion (Naidu et al, 1995; McAteer et al, 1997; Light et al, 2000).

However, learners need not actively participate in asynchronous discussion in order to benefit. It has been proposed that "vicarious learning" through observing a dialogue is an effective means for students to become accustomed to the knowledge and practices within a domain (McKendree et al, 1998; Mayes et al, 2002). In asynchronous discussion, this would seem to hold true for the naturally inhibited and more generally. The main benefits learners associate with reading contributions from their peers is to "find out what level everyone else is on", and as an additional study aid in which issues are discussed in terms learners are readily able to understand (Light et al, 1997, p. 232).

For some students then, participation in asynchronous discussion does have tangible learning benefits, and may even aid the learning of those on the periphery of an online discussion. However, an important proviso to students finding participation in asynchronous discussion non-problematic and worthwhile would seem to be an understanding of what asynchronous discussion is and involves. Related to this issue, it is often the case that when students are provided with and invited to use asynchronous communication facilities, they either do not use them or do not use them constructively (Crook, 1994, 1997a; Angeli et al, 2003; Beasley & Smyth, 2004). In addressing this common occurrence, Tolmie & Boyle (2000) stress that in considering the extent to which asynchronous communication might support learning it must be recognised that "productive use is not just a function of generic system affordances" (p. 121). Instead they strongly argue for the importance of learners having a "shared purpose" for participating in online discussion, and identify a number of factors that provide this.

2.4 RESEARCH INTO LEARNING VIA NLEs

Having established that the claims made for the affordances of hypertext, multimedia, and asynchronous discussion do have a theoretical and often empirical basis, in moving further towards an understanding of how students approach and experience networked learning there are a number of questions to address. These concern whether learners interact with NLEs in a manner conducive to realising the potential affordances available, what they perceive of the networked learning experience, and what can be determined about the quality of networked learning outcomes. Unfortunately despite the wealth of literature on networked learning, the consensus is that an over-reliance on theoretical and anecdotal descriptions of practice has been at the expense of focussed investigations into student usage, perception and knowledge gains (Ward & Newlands, 1998; Windschitl, 1998; Angulo & Bruce, 1999; Goodyear et al, 2004). However, an overview of the research that does exist in these areas provides sufficient insight to raise some pertinent issues, and identify some shortcomings in our understanding.

2.4.1 STUDENT INTERACTION WITH NLES

Although gradually becoming less so, research into students' networked learning interactions and perceptions has been predominantly quantitative. In both these areas this has important implications for our understanding, and in relation to the first largely serves to indicate that many learners do not utilise NLEs as effectively as possible.

One of the main affordances associated with NLEs is that the individual can access the environment at a time most conducive to learning, and then proceed to learn at their own preferred pace. Yet study time distribution analyses have shown that many learners generally fail to act upon this opportunity, with only a minority studying online throughout the duration of the course, and interaction with NLEs for the majority occurring immediately prior to exams or other formal deadlines (Taraban et al, 1999; Smeaton & Keogh, 1999; Baugher et al, 2003). Taraban et al (1999) attribute this to an inappropriate reliance on studying habits established through traditional courses in which pre-test learning is commonplace, and which for many students results in their adaptation to online learning effectively being "jeopardized" (p. 268).

Another potential factor in learners failing to manage their online study time is that the autonomous nature of NLEs allows learning to be postponed when other commitments loom. In a large early investigation, Hiltz (1997) found a significant majority of learners had indulged in this practice, with the outcome for many being that "this procrastination all too easily turns into falling seriously behind" (p. 9). Yet it should also be acknowledged that when learners do opt to interact with NLEs, there is some evidence to indicate that "students do, in fact, shift their learning – often to the middle of the night" (Bourne et al, 1997, p. 52). Thus whether or not the opportunity to learn autonomously is exploited for good or poor studying practice, it is certainly exploited.

Doubts also exist over the amount of networked learning that does actually occur online, as it seems many learners prefer to print out hypertext-based course materials for reading offline (Crook, 1997b; Ward & Newlands, 1998; Beasley & Smyth, 2004). This number approached ninety percent in the investigation by Crook (Ibid), and for many learners this may be an exclusive practice. Over two thirds of those surveyed by Ward & Newlands (Ibid) reported printing out hypertext documents straight away, compared to around a third who read online prior to printing, and just one or two were reading exclusively online. Through focus groups, Crook (1997b) uncovered a number of possible reasons for this practice. Learners felt more comfortable owning paper copy, disliked reading from the screen, and were sometimes under pressure to release terminals in busy IT labs. All are valid reasons, but nevertheless "incompatible with sustained study of hypertext material" (p. 242). Ward & Newlands' (1998) interpretation was more critical, and it was felt that the learners who simply printed out their course materials "seem to have been trying to replicate the conditions of a traditional lecture system. The main objective of their time at the computer was to generate paper copy of the lectures" (p. 182). In the case study reported by Beasley & Smyth (2004), which involved a part-time distance learning online course, students used print-outs more often at home, and the online environment more often at work. However print was preferred overall, and even when the students were online, they very rarely used the interactive or non-linear navigational options that were provided to allow a more active, problem-based approach to working through the course material.

The extent to which students interact with networked resources online is felt to be important because working offline may result in less interaction with constituent elements than is necessary for optimum learning to occur (Taraban at. al., 1999). A failure to study online may even cancel out altogether the opportunities for interacting with certain features of networked environments. For example, Crook (1997b) observes that when studying online the learner can contact the tutor via asynchronous communication tools to ask questions or articulate difficulties in understanding at the most optimum point in time - the moment they occur. He extends his argument to the cognitive benefits associated with learning from educational hypertext, noting that "exploring such semantic links does depend on a willingness to study hypertext material at a computer terminal" (p. 243). Similarly Ward & Newlands (1998) lamented the relative non-use of external links embedded within networked materials, and of the web to seek out additional material, by the students involved in their research. They postulated that "these results, like the evidence that most students did not read web materials at the computer but simply printed them straight away, suggest a conservative approach to learning and a reluctance to explore and experiment" (p. 182) [28].

2.4.2 STUDENT PERCEPTIONS OF NETWORKED LEARNING

Given that student interaction with NLEs can, on the whole, be seen as less effective than it might be, it is interesting that learners generally seem to view networked learning as a positive educational experience. Consistent with what is commonly theorised as being the main benefit, investigations into student perceptions of networked learning repeatedly find that the opportunity for autonomous, self-paced learning is highly valued (Tait, 1998; Ward & Newlands, 1998; Angulo & Bruce, 1999; Shaw, 2000; Song

[28] Timely and online interaction with NLEs and their constituent elements will emerge as critical aspects of how individuals approach networked learning, and the subsequent quality of their learning outcomes.

et al, 2004). Typical comments in the survey undertaken by Tait (1998) found students agreeing that “you can go at your own speed”, “work whenever you feel like it”, and that “it allows you to go back and review” material as required. Specific benefits attributable to the hypertext format of material included the ability to “cross check things”, and “skim through things you understand and work more slowly through things you don’t” (p. 420-421). In comparison with traditional courses, another advantage perceived was in the completeness of information that is provided online. Unlike with taking notes in lectures, it is felt there is no possibility of important points being partially or fully omitted, and learners seem to gain reassurance from the knowledge that “with a computer you can never miss a lecture” (Ward & Newlands, 1998, p. 178).

Autonomous access to hypertext course material aside, when opinions on the value of other features in networked environments have been sought these have also been largely positive. In the study by Angulo & Bruce (2000), the most highly rated feature of the environment in question was the asynchronous conference, liked for the typical reasons relating to reflective participation in discussion that the literature has us come to expect. Similarly, learners have been found to regard the tutor as being more accessible within a networked learning context as they are contactable via asynchronous communication facilities at any point in time. Approaching or exceeding seventy percent of learners in the research conducted by Hiltz (1997) and Shaw (2000) confirmed this, although the former points out that this obviously depends upon the tutor making themselves readily available online. Supportive visual multimedia were a key part of the environment Tait (1998) studied, and learners commenting on this feature typically stated that they experienced a “clearer practical understanding through animations and videos” (p. 424).

Student ratings of networked learning that are more affective in nature confirm that for many the experience is a rewarding one. Crook (1997b) found that over eighty percent enjoyed networked learning more relative to their other courses. Students have also perceived it to give them increased freedom and responsibility for their own learning (Bostock, 1998), which has been associated with feeling that networked learning has engaged them more actively in the learning process (Hiltz, 1997; Shaw, 2000; Song et al, 2004). Although survey data of this kind provides only marginal insight into the student experience by telling us only broadly how they feel, it does provide some support for the claims made regarding NLEs. At the same time, however, such research also highlights a number of negative factors students associate with networked learning.

For every majority who express an enjoyment of networked learning, the increased self-responsibility involved, and feel more actively involved in the learning process, there is a minority who are unsure or negatively rate these aspects of it. Motivation appears to be a major contributory factor, and some learners have commented on the greater "need to motivate yourself" when working online, and the "tendency to take the course very easily" when working largely independently in the absence of tutors (Tait, 1998, p. 418). Despite the increased level of tutor accessibility reported elsewhere, in both Tait's (Ibid) study and that of Ward & Newlands (1998), a number of learners were concerned about the lack of face-to-face contact with lecturers and also fellow students. This was mainly attributed to there being no opportunity to ask the tutor questions and receive instant clarification, or similarly seek assistance from peers. It was thought the absence of the interpersonal interaction that occurs in lecture and seminars resulted in an impersonal way of learning, and for some it was clear that "facing a computer would be much more boring than any lecture" (Ward & Newlands, 1998, p. 176).

Although learners associate many positive factors with networked learning, perhaps the strongest indication that not all find it a wholly rewarding experience is the consistency with which the vast majority in student cohorts state that they would not like a NLE to be the only source of learning within a course (Bostock, 1998; Ward & Newlands, 1998; Angulo & Bruce, 1999; Shaw, 2000). The consensus is that NLEs could support the self-paced learning of course content, but should be enhanced through periodic seminars to provide the face-to-face element missing in the online environment.

However, rather than the desire for a mixed-method approach genuinely reflecting the limitations inherent in networked learning, both Bostock (1998) and Tait (1998) question whether the dissatisfaction with aspects of networked learning that some individuals feel may instead be down to them not possessing the skills required for effective networked learning. That this was the likely explanation also identified by Taraban et al (1999) in relation to online time management, Ward & Newlands (1998) in relation to printing material to read offline, and has also been acknowledged as a factor in the poor use of asynchronous discussion facilities, suggests that studying skills and mindset are key determinants of how effectively an individual student learns online.

The salient point for the moment is that a discrepancy exists between the less than optimum ways some learners interact with NLEs, and the positive attributes they often associate with using them. Considered alongside the fact that elements of traditional courses are clearly missed, an obvious question that arises from this conflicting evidence concerns the quality of learning that results from interacting with NLEs.

2.4.3 THE QUALITY OF NETWORKED LEARNING OUTCOMES

Although research on networked learning interactions and perceptions can tell us something about how students interact with NLEs, and what they think about learning in this way, there is a lack of research relating directly to knowledge gained. However, a small number of experimental studies have attempted to measure networked learning outcomes, typically through comparing NLE and lecture-based groups (e.g. Gilliver et al, 1998; Ricketts et al, 2000; Maki et al, 2000, Koory, 2003). By analysing performance on formal assessments, rather than relying solely on student perceptions of outcomes, at a minimum these studies provide a fairly reliable indication of how successful the networked learning in a particular context has been. What becomes apparent on evaluating this research is that despite the reservations some students have about networked learning, the overall evidence suggests that learning outcomes are at the least comparable to lecture-based courses, and can sometimes be better.

A case in point is the study by Ricketts et al (2000). Students were given the option of undertaking the module in lecture-based format, or via a hybrid networked CD-ROM/web environment providing access to video lectures, supportive multimedia, computer conferences, and web resource links. Post-course assessment indicated the level of knowledge gained "was greater in the distributed [networked] groups every semester" during the period of investigation (p. 143). That the networked learners were a self-selecting group must be acknowledged, but what the findings were taken to indicate is that when learners are ready and willing to interact with NLEs, then certainly "distributed courses can be as effective as traditional courses" (p. 144).

Similarly the study by Maki (2000) found that "students in the on-line version of the course scored higher than students in the lecture version on periodic in-class examinations [and] also showed larger gains during the course on a set of questions covering a broad range of topics in psychology" (p. 237). Consistent with much research concerning student satisfaction with networked learning, a post-course evaluation found the on-line group rated highly the flexibility of learning online. However, lectures were rated more highly than the NLE in terms of how interesting the course was found to be, the likely reason identified being the enthusiasm with which the principal instructor delivered lectures to the non on-line group. Perhaps further proof that when courses are delivered through NLEs, it can be difficult for the learner to maintain their interest and motivation when working alone via the computer screen?

2.4.4 FACTORS THAT MAY INFLUENCE LEARNING VIA NLEs

Despite the claims that can be made regarding the educational potential of NLEs, the literature identifies a number of instructional factors that might be expected to influence how students use and learn from networked environments and their constituent elements. These include: factors that provide alternative explanations for the effectiveness of learning from hypermedia; learning tasks; and the role of the tutor.

Najjar (1996) identifies a number of alternative explanations for any apparent cognitive benefits of hypermedia and multimedia, including instructional activity, interactivity, and the novelty effect. The argument concerning instructional activity is that in designing for a hypermedia environment, the instructor is effectively revisiting and enhancing the quality of their existing knowledge and instructional materials. On interactivity, it is proposed that students may take a more positive approach to learning via an interactive environment than receiving traditional instruction. Related to this, it is also possible that studying via hypermedia may well provide a temporary stimulation to learn that would fade over time, hence the term "novelty effect" (p. 131-132). Najjar (1996) believes any one of these factors provides a reasonable explanation for positive effects in situations when the instructional method and level of interactivity are not comparable, or when interaction with the environment has been for a short period only. Clark (1983; Clark & Craig, 1992) has also long argued that the short-term novelty of interacting with hypermedia should not be ruled out when interpreting research.

If interacting with technology-based environments does stimulate an initial interest in or motivation for learning, then arguably the most important instructional factor in sustained studying via educational technology, whether online or not, are the learning tasks to be undertaken. With reference to networked learning contexts, Goodyear (2002) echoes the current view on what effective learning tasks generally are by stressing the need for tasks that are activity-based, and provide students with a rationale and focus for utilising the online resources at their disposal. Without such tasks, the danger is that "students flounder around unproductively and unhappily, not knowing what is expected of them" (p. 67) in interacting with their environments.

There is considerable empirical support for this claim. Comparative studies of different educational hypertext structures have acknowledged the overriding importance of task to encouraging effective student interaction (e.g. Brown, 1997; Shapiro, 1998). Jonassen & Wang (1993) found that only those assigned a relevant task prior to interacting with a semantically structured hypertext demonstrated significant conceptual knowledge gains. From this they concluded, consistent with a core constructivist ideal, "that learning from hypertext must rely on externally imposed or mediated learning tasks…merely browsing through a knowledge base does not engender deep enough processing to result in meaningful learning" (p. 7) [29]. Similarly, it is known from research involving online communication that simply providing facilities for this is unlikely to result in students actively using them to engage in discussion with tutors and peers (Crook, 1994, 1997a; Beasley & Smyth, 2003, Angeli et al, 2004).

Of the diverse range of factors thought to impact on how effectively students interact with asynchronous discussion facilities, including group size, social diversity, learner experience and rules governing participation (McAteer et al, 1997; Seale & Cann, 2000; Tolmie & Boyle, 2000), the issues of task and task appropriateness are particularly well understood. As a general rule, any task must provide students with an explicit reason for participating in computer-mediated discussion, and preferably one "that cannot be served more easily in another way" (Tolmie & Boyle, 2000, p. 123).

Guidance on suitable tasks for asynchronous communication abound, most recently and notably in Salmon's (2002) work on "E-tivities", although there is a general consensus that critical debate, student-led seminars, research and report tasks, and exploration of problems and possible solutions are well suited to the asynchronous discussion, whereas tasks requiring rapid generation of ideas and quick decision-making are not (Mason, 1994; Newman et al, 1997; Tolmie & Boyle, 2000; Salmon, 2002).

Beyond being appropriate, whether tasks are assessed can also influence how students utilise online resources. The issue of assessment is another that is well understood in relation to online communication, and it is unsurprising that the assessment of contributions is consistently found to provide learners with a strong motivation to

[29] In the ecological terms of affordances, it could be said that having a relevant learning task to undertake provides the learner with a perceived need for interacting with a hypertext in an active and meaningful way.

participate in discussions (Yakimovicz & Murphy, 1995; Goodyear, 1996; Buckner & Morss, 1999; Light et al, 2000). If it is accepted that learners are less likely to use asynchronous discussion facilities just because they are available, then this might be viewed as positively contributing, in conjunction with task, to the explicit purpose deemed necessary to ensuring participation. The reason is that learners will perceive their participation in asynchronous discussion to be "a legitimate part of their contract" if they are being assessed (McAteer et al, 1997, p. 225). One proposed consequence of this is that learners will then tend to be more conscientious about the content and frequency of their contributions to discussions [30]. However, the point about assessment and the perceived legitimacy of activity can be equally applied to anything learners are required to do when interacting with a networked environment, from studying the core content to collaborating to undertaking individual tasks. Without being assessed for their networked learning efforts, there is a danger that students may see certain uses of the technology as "peripheral" to course requirements, and invest in their use of the available resources "less effort than they otherwise would" (Laurillard, 2002, p. 205).

The final instructional factor that can be expected to influence how students interact with networked environments is the role of the tutor. Much has been written about the multifarious responsibilities this entails (e.g. Berge, 1995; McConnell, 2000; Salmon, 2000). Reflecting the shift to a more student-centered experience that networked learning involves, on a pedagogical basis the role of the tutor is seen - consistent with constructivist perspectives - to have changed "from the sage on the stage to the guide on the side" (Steeples & Jones, 2002, p. 9). As a facilitator of learning rather than the source of knowledge, the tutor is essentially required to concentrate their efforts on

[30] Conversely, there is some evidence that making discussion tasks compulsory may encourage a negative assessment-driven approach to participation. This may result in lengthy monologues unsuited to discussion, but seen as conducive to achieving high grades (Seale & Cann, 2000; Light et al, 2000).

ensuring an active and rewarding approach to networked learning for the students concerned. This demands that they be pro-active in a number of areas, principally including the orientation of students towards learning online, stimulating and maintaining online discussions, and assuming a more 'traditional' role as required (Hiltz, 1994; Berge, 1995; Harasim et al, 1995; McConnell, 2000; Salmon, 2000).

Orientating learners towards networked learning requires that the tutor communicate to the students both the purpose of networked materials and resources, i.e. what they are for, and also how they are to be used. In practical terms, this should include explicit guidance information within the environment itself. As discussed, there is much evidence to indicate that some students do not possess the skills or mindset required for learning online, and when required to do so will rely on established methods of studying developed in, and more appropriate for, conventional courses (Crook, 1997b; Bostock, 1998; Ward & Newlands, 1998; Taraben et al, 1999). At a broad level, providing "metacognitive" information describing the features, purpose and expected use might aid those who are new to online learning, but in any case should help students understand how an NLE is intended to support their learning and how they should contribute towards this (Sumner & Taylor, 1998; Collis & Meeuwsen, 1999).

For example, in being presented with non-linear hypertext material intended to support the development of a rich, multi-perspective understanding, research shows that students are much more likely to explore it in a non-linear manner if they are provided with clear navigational guidance embedded within the material itself (Veenman et al, 1994; Relan & Smith, 1996; Kashihar et al., 1999). For asynchronous discussion, the tutor might provide the required guidance "with an opening comment that clearly states the subject of the conference, the agenda...and expectations for student participation (volume, frequency, type of comments etc.)" (Harasim et al, 1995, p. 176).

Following the communication of such information at the outset, the tutor should then assume responsibility for instigating initial online discussions. Berge (1995) notes this is typically achieved through them providing some background information, comments, or even references to appropriate readings, and concluding with questions or pointers intended to stimulate discussion or collaboration. Once underway, the tutor would typically have a degree of responsibility for maintaining discussions. This may simply involve periodically posting questions or comments to the group to introduce new perspectives or issues of relevance. It might also require them to synthesise previous points in order to prompt reflection and move the discussion on. In this respect the tutor is functioning more fully in a 'traditional' role to ensure misunderstandings are ironed out and critical issues addressed (Hiltz, 1994; Berge, 1995; Harasim et al, 1995).

Given these responsibilities of the tutor-as-facilitator, it seems reasonable to expect the pro-activity of the tutor to influence student participation in asynchronous discussion, and the resulting quality of their learning. Factors that students associate with effective tutor facilitation of online discussion, and of networked learning generally, include frequent participation in discussions, posting relevant questions, affirming valid viewpoints, and responding in a timely manner to questions and requests for help (Hiltz, 1994; Salmon, 2004). In addition to indicating that networked learners may actually desire the tutor to function in a moderating capacity, this also demonstrates that their opinion may be a significant factor in enabling learners to determine the quality of the understanding they have arrived at through studying with the available resources and participating in online discussions. Regardless of the tutor's role shifting to a facilitating one, it is likely that some learners will nevertheless perceive the tutors opinions to be more legitimate than that of their peers (Jones, 1999). As students have been found to observe on this issue: "tutor answers are usually more thought through and right, otherwise they would not be tutors, whereas students answers are usually less clear and come with "I think" and "probably"" (Wilson & Whitelock, 1998, p. 261).

2.5 LEARNING STYLES AND APPROACHES

There are a number of individual factors on which learners are thought to vary that provide possible explanations for why some learn more effectively than others. These factors include forms of general intelligence such as verbal and reading comprehension, relevant prior knowledge, intrinsic and extrinsic motivation, test or evaluation anxiety, self-regulatory ability, and personality traits such as introversion and extroversion (Goodyear et al, 1991; Jonassen & Grabowski, 1993; Snow, 1997). Within the field of educational technology, of increasing interest is the factor generally referred to as 'learning style', and in recent years a number of studies have attempted to assess the influence this has upon how students learn via technology-based environments.

2.5.1 THE NATURE OF LEARNING STYLE

The term 'learning style' is widely used to describe the practices of the individual when undertaking some form of learning task in an instructional context. However, it has been noted that the specific nature of what constitutes learning style is not well understood due to the range of indicative attributes, labels and measures used by those who investigate it (Jonassen & Grabowski, 1993; Riding & Rayner, 1998). The main point of contention, which is certainly evident within the research on learning style and educational technology, is that often what is commonly referred to as learning style instead reflects the related but distinct factor of cognitive style. Cognitive style can essentially be defined as an individual's "habitual approach to organising and representing information" (Riding & Rayner, 1998, p. 8). The defining characteristics of cognitive styles are that they "are concerned with the form rather than the content of cognitive activity", i.e. individual differences in how rather than what we learn, and that they are relatively stable over time to the extent that "we can predict with some accuracy that a person who has a particular style one day will have the same style the next day, month, and perhaps even years later" (Witkin et al, 1977, p. 15).

Rather than concerning how the individual is pre-disposed to perceiving and processing information, learning styles encapsulate "the attitudes and behaviours which determine an individual's preferred way of learning" (Honey & Mumford, 1992, p. 1). This is reflected in the strategies and types of activity that the individual feels most comfortable with when learning. In this respect it can be reasoned that "learning styles, in effect, are applied cognitive styles, removed one more level from pure processing ability" (Jonassen & Grabowski, 1993, p. 233). Although learning styles represent general preferences and tendencies, an important difference to cognitive style is that they do have the potential to change both over time, and also in response to the demands of particular learning contexts (Schmeck, 1988). The adaptability of learning styles has important implications that will be returned to. Regarding the wide range of cognitive and learning style classifications that exist, a number of the more established and relevant variations on each construct are summarised within Table 03.

TABLE 03: ESTABLISHED COGNITIVE AND LEARNING STYLE CLASSIFICATIONS

Cognitive Style	Defining Characteristic
Wholist-analytic/verbal-imagery	Comprising two cognitive style dimensions: the tendency of the individual to process information in whole or parts; and tendency during thinking to represent information either verbally, or visually in the form of mental pictures.
Field-dependence/field-independence	Global vs. articulated orientation. Manifested in the extent to which the learner is constrained in their understanding by the totality of the information provided, or is able to impose their own meaningful structure upon the perceived field.
Holist/Serialist	Holists operate on the level of themes, focusing on several aspects of a subject simultaneously to form conceptual interconnections. Serialists focus on one specific aspect, and proceed only when satisfied of their understanding.
Learning Style	**Defining Characteristic**
Diverger/assimilator/converger/accommodator	Learning style is determined by individual preferences for concrete experience or abstract conceptualisation on a perception dimension, and reflective observation or active experimentation on an information processing dimension.
Activist/reflector/theorist/pragmatist	Determined by strength of learner preference to either fully involve themselves in new experiences, observe and ponder from different perspectives, think systematically and form complex theories, or test the practical applicability of ideas.
Deep/surface/strategic	Principally manifested in the tendency for learners to either focus on understanding meaning when studying, learn through rote memorisation of prominent information, or tailor studying towards maximising academic achievement.

For Riding and colleagues (Riding & Sadler-Smith, 1992; Riding & Rayner, 1998; Sadler-Smith & Riding, 1999), the various descriptions of cognitive style within the literature can be classified as belonging to either a wholist-analytic or verbal-imagery dimension. The first relates to the way in which the individual processes information. Wholists "tend to see the whole of a situation, and are able to have an overall perspective" whilst "analytics will see the situation as a collection of parts and will often focus on one or two of these at a time, to the exclusion of the others" (Riding and Sadler-Smith, 1992, p. 327). The second relates to the way in which information is represented during thought, with verbalisers thinking in terms of words and their associations, and imagers pre-disposed to forming pictorial representations. An important implication of cognitive and also learning styles, regardless of the classification, is that individuals might be expected to learn more effectively under different instructional conditions. Thus it is proposed that on the orthogonal wholist-analytic and verbal-imager dimensions, an individual classified as an analytic-imager would prefer and benefit most from material that is clearly structured and with a high level of diagrammatic or pictorial content (Sadler-Smith & Riding, 1999).

The conceptual basis for the wholist-analytic dimension is the field dependence/field independence classification of cognitive style (Witkin et al, 1971; 1977). Arguably the most extensively researched construct of its kind, and the one most frequently used to investigate student interaction with educational technology, the essence of field-dependence/independence is "the extent to which the person perceives part of a field as discrete from the surrounding field as a whole, rather than embedded in the field" (Witkin et al, 1977, p. 7). In common with other cognitive and learning style constructs, a unique instrument is used to determine the style of the individual. Measures of cognitive style tend to involve performance on tests considered direct indicators of information processing ability, and for assessing field dependence/independence the instrument used is the Embedded Figures Test (EFT) (Witkin et al, 1971). This basically involves exposing the individual to simple diagrammatic figures, followed by more complex diagrams in which they attempt to locate the preceding simple shapes in the allocated time. Field dependent learners are those who have trouble discerning specific items of information from the totality of that presented, whilst field independent learners are readily able to disambiguate between the specific items of information presented within a particular context. Regards the general implications, the belief is that "field independents are more likely to reorganize, restructure, or represent information to suit their own need, conceptions, or perceptions [whilst] field dependents are more likely to accept and encode the information in their own memories as it is presented" (Jonassen & Grabowski, 1993, p. 87).

As a final illustration of cognitive style, another important distinction is between holist and serialist learners (Pask & Scott, 1972; Pask, 1976). This reflects the favoured strategies for information processing the individual is inclined to use. Pask (1976) states of the main holist/serialist distinction that "the holist has many goals and working topics under his aim topic; the serialist has one goal and working topic" (p. 130). The holist typically works on the level of developing themes, discovering conceptual connections, and forming broad hypotheses, whilst the serialist restricts their focus to a single topic at a time, working linearly based on immediate connections. The holist and serialist strategies are respectively thought to reflect a predisposition towards the cognitive styles of comprehension (meaning-making) and operation (logical replication) learning. As both are essential to developing understanding, then an over-reliance on either strategy can prove detrimental. A strong bias towards comprehension learning may result in the forming of over-generalised analogies. A particularly negative serialist strategy is the rote memorisation of facts for subsequent recall.

Cognitive style is not addressed within the empirical part of this research, but is relevant for differentiating between cognitive and learning style, and because of the amount of research on individual differences and educational technology that has focused on cognitive style dimensions. Furthermore, a fundamental difference in the ways students attempt to process information, as exemplified in cognitive style descriptions, is a critical feature of the 'learning style' construct that is used within this research.

Of the learning style classification schemes that are commonly applied in researching student interaction with educational technology, the best known originates from the experiential learning theory of Kolb (1984). This views learning as an adaptive process grounded in our transactions with the environment, and through which "knowledge results from the combination of grasping experience and transforming it" (p. 41). This process is described in terms of a four-stage cycle comprising the experiential learning modes of concrete experience, reflective observation, abstract conceptualization, and active experimentation. Although Kolb (1984; 1985) contends that the learner should ideally be able to function in any mode as required, he believed the possible combination of preferences on each continuum corresponded to four unique learning styles. Divergers have a preference for grasping experience concretely through engagement in activity, and transform knowledge through reflection. Assimilators are abstract conceptualizers who reflect, and in an instructional context may learn most effectively through traditional instruction and reading. Convergers are abstract conceptualizers who transform through active experimentation, and so prefer traditional instruction followed by practical application of knowledge. Lastly, accomodators favour concrete experience and active experimentation, both acquiring and testing knowledge most effectively through experimentation and problem-based activities. In contrast with cognitive styles, assessed via tests of ability, learning styles are typically measured via self-reporting inventories focused on preferred learning practices. The Learning Styles Inventory (LSI) (Kolb, 1985) is composed of behavioural statements such as 'I am careful not to jump to conclusions too quickly' and 'I learn best from observation'. In common with similar instruments, scores on questions relating to specific learning styles are calculated to identify the dominant one [31].

[31] The reliability of such inventories as a measure of learning style, and their generalizability in providing an insight into learning via educational technologies, will be addressed within the methodology chapter.

After Kolb, the second classification scheme often used to research learning styles and interaction with educational technology is that of Honey & Mumford (1992). Although conceptually based on Kolb's experiential learning cycle and LSI, as their own scheme and inventory was devised to be more indicative of how individuals learn within organisational contexts, the rationale was for the Learning Styles Questionnaire (LSQ) to "refrain from asking direct questions about how people learn [and] instead on what managers and professional people do" (p. 4). Statements therefore take such forms as 'I actively seek out new experiences', 'on balance I talk more than I listen', and 'I tend to be a perfectionist'. The associated learning styles consist of activist, reflector, theorist and pragmatist. Respectively these correspond with a general orientation towards: full and open-minded participation in new experience; cautiously observing experience from different perspectives before committing to action; integrating observations into complex but logically sound theories and working methodologically; and applying theories and techniques in practice whilst always searching out new ideas. While being similar to Kolb's work, the more general nature of Honey & Mumford's scheme may explain why it is regularly applied within educational research (Valley, 1997).

2.5.2 THE APPROACHES TO STUDYING CONSTRUCT

The 'learning style' construct considered most relevant to this research is grounded within the phenomenographic tradition of educational research pioneered by Marton & Saljo (1976a; 1976b). Concerned with a lack of understanding about qualitative differences in how learners attempt to grasp content, as opposed to quantitative differences in how much they learn, Marton & Saljo investigated learning under naturalistic conditions, and from the subjective viewpoint of the learners themselves [32].

[32] It is the emphasis on understanding the experience of learning and studying from subjective viewpoints, typically those of learners but sometimes those of educators, that basically characterises phenomenographic research.

Their first major series of experiments required students to read an academic text, after which they were questioned on their reading strategy and what they understood of the content. In analysing the descriptions given, learners were found to have addressed the task in one of two mutually exclusive ways. These were termed surface-level and deep-level processing, the basic distinction being that "in surface-level processing the subject focuses on the sign (i.e., the discourse itself or the recall of it)...deep-level processing indicated that students had concentrated on what is signified (i.e., what the discourse is about)" (Marton & Saljo, 1976a, p. 9). The emphasis on meaning implicit in deep-level processing consistently resulted in rich conceptual understanding, whilst surface-level processing resulted in no more than a basic level of familiarity with content.

Marton & Saljo (1997) note that whilst they initially described the deep/surface distinction as different levels of information processing, subsequent research found this to be too narrow a conceptualisation of the differences in how individuals learn, and misleading given that it was actually a learners intention to focus either on sign or signified. For these reasons the term 'approaches to learning' was widely adopted, with the major contribution to our understanding of this concept as a variant on the notion of learning style originating within the work of Entwistle and associates (Enwtistle et al, 1979a; 1979b; Entwistle & Ramsden, 1983). Based partially on the leading theories and beliefs about student learning and motivation contemporary at the time, the emphasis was on developing a quantitative tool that could be used to assess, and enhance knowledge about, how individuals undertake learning within higher educational contexts. The result was the Lancaster Inventory of Approaches to Learning, a multi-scale inventory that assessed individual propensity towards taking a deep, surface or strategic approach to studying, as well as the dominant form of academic motivation (Entwistle et al, 1979a). Using phrases derived from common descriptions provided by learners during qualitative research into aspects of the learning experience, the inventory included items for Pask's comprehension and operation cognitive styles which were seen as implied within the deep and surface approaches respectively. The principal characteristics of the deep, surface and strategic approaches to studying, as they have more recently been conceptualised, are shown in Table 04 (Entwistle, 1997).

TABLE 04: APPROACHES TO STUDYING AND THEIR DEFINING CHARACTERISTICS

Deep Approach	**Transforming by**
Intention – understand ideas for yourself	Relating ideas to previous knowledge and experience Looking for patterns and underlying principles Checking evidence and relating it to conclusions Examining logic and argument cautiously and critically Becoming actively interested in the course content
Surface Approach	**Reproducing by**
Intention – cope with course requirements	Studying without reflecting on purpose or strategy Treating the course as unrelated bits of knowledge Memorising facts and procedures routinely Finding difficulty in making sense of new ideas presented Feeling undue pressure and worry about work
Strategic Approach	**Organising by**
Intention – achieve highest possible grades	Putting consistent effort into studying Finding the right conditions and materials for studying Managing time and effort effectively Being alert to assessment requirements and criteria Gearing work to the perceived preferences of lecturers
Adapted from Entwistle (1997)	

Broadly, an individual's approach to studying is held to "comprise a relation between the person and the material being learned" (Ramsden, 1992, p. 40). In essence, the learning that occurs within a particular context, at task or course level, is mediated by what the student perceives to be demanded of them, and the methods employed to cope with those demands (in this respect, an 'approach to studying' is less a 'learning style' per se, and more a set of 'applied learning preferences').

As indicated, each of the main approaches is characterised by a distinct form of intent towards learning. This is termed a "study orientation", and for the deep, surface and strategic approaches the corresponding orientations relate to meaning, reproducing, and achieving (Entwistle, 1997, p. 21-22). The intentional aspect of the deep approach is to understand ideas for oneself through transforming course content, of the surface approach to cope with course requirements through replicating content, and of the strategic approach to gain optimum grades through highly organised studying.

Associated with each approach are the learning processes, or methods, that are essentially manifestations in practice of the underlying study orientations. The deep approach learner is thought to actively challenge the ideas and arguments they are presented with, involving themselves in a process of "reconstructing knowledge within a personal framework" through forging links between new information, existing knowledge, and personal experience (Entwistle, 1988, p. 24). For the surface approach learner "there is little or no personal engagement in the act of learning", and they fail to appreciate links through an over-reliance on memorising facts and procedures for subsequent recall (in cognitive terms, they mainly focus on building declarative knowledge) (Ibid, p. 24). Lastly, the strategic approach learner is adaptive and efficient, cue-seeking to accurately determine the assessment criteria and effectively managing their time and resources. Although the deep and surface approaches are viewed as mutually exclusive, those with strategic tendencies may undertake meaning-orientated and reproducing-orientated learning as deemed necessary. However, while individuals with a deep approach to learning may also be found to exhibit strategic tendencies, surface approach learners generally are not (Entwistle & Ramsden, 1983). The content of what is now termed the Approaches to Studying Inventory (ASI) further exemplifies the nature of each approach. Items representing aspects of the deep, surface and strategic approaches respectively take the form of statements such as 'I look at the evidence carefully and try to reach my own conclusion about what I'm studying', 'I often have trouble in making sense of the things I have to remember', and 'I'm good at following up some of the reading suggested by lecturers or tutors' (Tait et al, 1997) [33].

Closely linked with how an individual approaches studying are a number of attitudinal factors that include personal conception of learning, and preferences for different forms of course delivery. Regarding the former, a phenomenographic study by Saljo (1979) found that students held one of five distinct conceptions of what learning actually involves. Whereas the first three conceptions perceive learning as "more or less verbatim item-by-item transfer of knowledge from an external source", the others assume that "knowledge is constructed by individuals as a result of active effort on the part of the learner" (p.21). A sixth conception, learning as a process of personal development, was subsequently added by Marton et al (1993).

Van Rossum & Schenk (1984) first discovered the relationship between individual conceptions of and approaches to learning. Consistent with previous research, learners who took a deep approach to comprehending a text developed a qualitatively better understanding. However in examining learning conceptions, almost every student with a reproductive conception of learning had taken a surface approach to the task, whilst those who viewed learning as an interpretative process had taken a deep approach. The link between conceptions of and approaches to learning raises an obvious question around how students might be supported in developing higher order conceptions of learning that encourage effective approaches to studying. More recent work by Marton and colleagues (Boulton-Lewis et al, 2000; 2004) suggests that one important factor in

[33] The specific version of the ASI used within the context of this research will be considered latterly.

students developing higher order conceptions of learning is simply through being exposed to a rich range of course contexts that encourage students to think about learning, and apply themselves to studying, in ways that are conducive to deep approaches. Another important factor here, as will be established, is around task clarity.

Regarding individual preferences for different types of teaching method, consistently associated with the deep approach is an appreciation of methods that support understanding, including courses that challenge the learner to think for themselves and read out with the immediate subject area. Linked with surface approach tendencies, on the other hand, is an appreciation of teaching that transmits information. This includes lecturers who tell students exactly what to put down in their notes, books giving facts rather than theories, and tests based solely on lecture material (Tait et al, 1997; 1998).

Although prone to evolve over time, perhaps as Marton et al (1993) suggest in response to increasing experience of higher education, personal conceptions of learning, and arguably also preferences for teaching, are individual traits likely to remain stable across contexts. As the intent of the learner is a key determinant in the approach taken, a pertinent issue is whether approaches are consistent or context-dependant. They are seen as both. Entwistle (1998) states that "students' approaches are affected by their prior educational and personal histories, which produce habitual patterns of study. However, the content and context evoke strategies which are specific to that particular situation" (p. 74). The point is that whilst an individual can generally be described as a surface or deep approach learner based on the studying methods they typically rely on, conditions can demand that they learn in ways atypical of their preferred approach.

Although Entwistle (1998) notes the variability of approaches is not fully understood, there is evidence for both their consistency and context-dependency. On the influence of prior educational experience, a link has been observed between the teaching culture of academic departments, essentially whether freedom in learning with an emphasis on understanding is encouraged, and the learning approach most common to a cohort in pursuit of their studies (Ramsden & Entwistle, 1981; Ramsden, 1988). The influence of situational context upon approach is basically an issue of task comprehension, as demonstrated in the second landmark study by Marton & Saljo (1976b). Learners were asked to read a text and complete a written knowledge test, with one group expecting factual questions and the other questions of a conceptual nature. Those perceiving a requirement to demonstrate factual knowledge attempted to memorise content, a surface approach trait, and those perceiving a requirement to demonstrate conceptual knowledge focused on meaning, a deep approach trait. Thus within the limited contexts of specific tasks it is certainly possible that "students adopt an approach determined by their expectations of what is required of them" (Marton & Saljo, 1976b, p.125).

Because approaches to studying are subject to contextual influence, the accepted aim of instruction in higher education is to facilitate a deep approach to learning. Across a broad spectrum of subject areas and forms of learning activity (e.g. the case studies presented by Gibbs, 1992; Marton et al, 1997) a deep approach is consistently associated with more effective learning and understanding. The instructional factors deemed necessary to encouraging a deep approach include an increased level of learner responsibility, opportunities to reflect on knowledge development, problem-based tasks, peer collaboration, and learning objectives that communicate the need to understand domain material (Gibbs, 1992, p. 12-16; Ramsden, 2003). In short, essentially the same instructional principles that are central to constructivist learning theory. Entwistle et al (1993) even suggest phenomenographic and related research reflects a distinct form of constructivism, namely the individualistic ways in which learners attempt to construct knowledge within higher educational contexts. One might then wonder to what extent individual approaches to studying, or more broadly learning style, influence how students interact with what can be considered constructivist educational technologies?

2.5.3 LEARNING STYLE AND INTERACTION WITH TECHNOLOGY

Unfortunately, as previously discussed, while the constructivist literature is strong on emphasising how to ensure learning in instructional contexts is a learner-centered experience, it has relatively little to say about how individualistic traits might affect how effectively or well students learn in constructivist environments. However, in relation to learning via technology there is some evidence to suggest that cognitive and learning styles are an important factor in determining how learning is undertaken.

Research into the relationship between cognitive and learning styles and interaction with educational technology has primarily been focussed on hypertext-based applications. This is unsurprising given that the main affordance claimed for the medium is allowing for idiosyncratic, needs-based exploration of knowledge domains (Jonassen, 1989). A significant amount of this research to date has addressed the impact that bipolar cognitive style dimensions have upon how students explore and interact with educational hypertexts, with the favoured cognitive style construct typically being Witkin's field dependence/field independence classification.

The majority of such studies have found that field dependent and field independent learners interact with hypertext environments in very different ways (Ellis et al, 1993; Liu & Reed, 1994; Chen & Ford, 1998; Fitzgerald & Semrau, 1998). Viewing the results collectively, it is apparent that whereas field dependent learners rely heavily on the basic navigational structure provided when exploring hypertext environments, field independent learners are far more self-determining in their interactions. This is well illustrated in the study by Chen & Ford (1998). The application in question could be explored freely through semantic links contained in the material, or via navigational aids including previous and next buttons and a topic menu. In addition to utilising the navigational features more frequently than field independent learners, who relied on the referential links to explore the domain, field dependent learners were unique in feeling overwhelmed by the volume of material presented, and in failing to navigate to deeper levels of conceptual coverage. In accordance with the other studies cited, this disparity in how field dependent and field independent learners interact with hypertext is claimed to be "consistent with [Witkin et al's] view that field dependent learners tend to employ a global, spectator and less analytic approach to learning" (p. 76).

The implication is that learners who are inclined towards developing a conceptual understanding for themselves will interact most actively with hypertext, and this is supported by the smaller number of studies in this area that have used indicators of learning style (e.g. Allinson, 1992; Lee & Lehman, 1993; Jacobson et al, 1996; Rasmussen & Davidson-Shivers, 1998). Allinson (1992) is one of the few researchers to have used a version of the Approaches to Studying Inventory as a determinant of 'learning style' in relation to educational hypertext, finding that surface approach learners prefer a linearly-structured presentation and progress more slowly, while deep approach learners are more frequent and self-regulatory in their interactions. Similarly, and employing an instrument termed the Passive-Active Learning Scale, Lee & Lehman (1993) discovered learners classified as active invested greater time in learning, and more frequently selected information embedded deep within a hypertext, than their passive counterparts. Finally, Rasmussen & Davidson-Shivers (1998) determined that strong 'active conceptualization' tendencies, assessed via the Kolb inventory, were aligned with effective interaction with a hypertext under user-controlled conditions.

However, results are less consistent regarding the relationship between cognitive or learning style, interaction with hypertext-based environments, and the quality of learning outcomes. A number of studies report no significant difference attributable to style dimensions, even though patterns of interaction vary between groups (Ellis et al, 1993; Fitzgerald & Semrau, 1998, and the meta-analysis of Chen & Rada, 1996). It has been suggested one possible explanation for this is that the accommodating nature of hypertext can "level the learning field", and so provide "equally effective instruction for learners regardless of their differences" (Fitzgerald & Semrau, 1998, p. 329). Yet studies that correlate aspects of learning style and outcomes would seem to dispute this claim (Lee & Lehman, 1993; Weller et al, 1995; Jacobson et al, 1996; Chuang, 1999).

All of these studies describe at least moderate advantages for learners who are more 'active' or 'conceptually-orientated' on the style dimensions used. The Jacobson et al (1996) study is of particular note. Learners interacted with hypertexts designed according to the constructivist principles of Cognitive Flexibility Theory, and outcomes were crossed with responses to an epistemic beliefs inventory. Using similar categories to the Saljo (1979) scheme, those viewing learning as a transformative process of understanding, a view known to be associated with taking a deep approach, consistently "achieved significantly higher scores on the transfer task than simple [epistemic beliefs] students" (p. 270). Weller et al (1995) also report considerable outcome differences, in this instance between field dependent and the superior field independent learners.

As Dillon & Gabbard (1998) observe, much of the inconsistent results pertaining to hypertext, learning styles and learning outcomes can reasonably be attributed to variations across particular contexts, and within the range of cognitive and learning style measurements that exist. They argue in particular for "style dimensions that show greater potential for predicting behaviour and performance" than the field dependent/field independent classification (p. 344). Within the confines of this research these are important points. Of equal importance is the apparent lack of empirical work on learning style and interaction with networked learning environments. According to Loomis (2000), "little, if any, research to this point has been conducted on student learning styles in relation to asynchronous learning networks" (p. 24) [34]. Despite this, a small number of studies have considered learning style and networked learning in some joint capacity, and so can offer a limited insight (e.g. Shih et al, 1998; Carswell et al, 2000; Federico, 2000; Mehlenbacher, 2000; Karuppan, 2001; Goodyear et al, 2003).

Loomis' (Ibid) own research used an inventory that included scales on learning attitude, time management, and motivation, and was applied within a case study of an online research methods environment. Correlating inventory scores with performance on various assignments, high scores on the aforementioned scales consistently matched high levels of achievement, and were also associated with student reports describing enjoyment of and positive feelings towards networked learning. The opposite was true of low scale scores, from which it was concluded that "some students do not have the skills to discipline themselves to adequately learn and study in a timely manner" in a networked context (p. 26). Federico (2000) and Karuppan (2001) both used the Kolb classification to look respectively at student attitudes towards networked learning, and use and outcomes. Results on learning style were consistent up to a point, with assimilators in the first study demonstrating more positive attitudes towards networked learning, and assimilators in the second study accessing the environment more frequently and learning more effectively. A possible explanation for the suitability of assimilators, i.e. abstract conceptualizers who reflect, being well suited to networked

[34] Goodyear et al (2003) have recently indicated that this remains the case.

learning is that this requires the individual to interact with and integrate large bodies of material from diverse sources, "a task in which assimilators usually excel and from which they learn best" (Karuppan, 2001, p. 146). The expected findings for the remaining Kolb learner styles were not completely as expected in either study, neither were they entirely consistent. Similarly the Honey and Mumford scheme, based on experiential learning theory, was used by Carswell et al (2000) but yielded no discernible outcome differences for any of the Honey and Mumford learning styles.

The Shih et al (1998) study provides an exception for applying a cognitive style measure to investigating interaction with a networked environment. However, consistent with some of the research on stand-alone hypertext applications there were no differences in achievement nor, more surprisingly, patterns of interaction. In common with Fitzgerald & Semrau (1998), Shih et al concluded that students "with different learning styles can learn equally well in web-based courses" (p. 363). Given the marginally greater insight into aspects of individual style and student use of educational technology that is provided through the use of learning style inventories, perhaps it can instead be argued that Dillon & Gabbard (1998) are correct in asserting that cognitive style measures are not sensitive enough to study learning behaviour and performance.

Returning to the lack of research into learning style and networked learning, very few studies appear to have used the Approaches to Studying Inventory (ASI) to measure what are arguably the best-known 'learning style' constructs in European educational research. In addition, there appears to have been little attempt to discern the effect learning style has upon interaction with the constituent elements of NLEs. This is presumably required to understand how learning styles help or hinder students in realising the range of affordances thought to be inherent in networked environments.

Light et al (1997), Gibbs (1999) and Goodyear et al (2003) have responded to these limitations in different ways. Light et al (Ibid) used the ASI to determine that deep approach learners were the most active participants in asynchronous discussion, and Gibbs (Ibid) to find that deep and strategic learners were more frequent users of an NLE. With a different focus, Goodyear and colleagues (Ibid) investigated student perceptions of networked learning in relation to approach classification and conceptions of the learning process. They found only tentative evidence to suggest that deep and strategic approach learners feel more positively about networked learning than those exhibiting a surface approach, and no evidence of a relationship between conceptions of learning and judgements about using NLEs. On this basis they concluded that "those who believe that students with more elaborate conceptions of learning are likely to be more positive about networked learning may need to revise their views" (Goodyear et al, 2003, p. 23), and that there are no grounds for assuming that "only students with sophisticated conceptions…or who adopt a deep approach to study, are likely to benefit from engagement in networked learning" (Ibid, p. 24).

On reflection, while the findings of research into learning styles and educational technology are inconsistent, on balance there is some basis for accepting a link between learning style, use of environments and learning outcomes does exist. Ultimately though, an obvious question concerns what assessments of cognitive processing ability, or measures of learning style designed to assess learning preferences in non-academic or even traditional academic contexts, can really tell us about how students respond to the demands of networked learning. Perhaps the critical issue should instead be whether students possess networked learning 'styles' or approaches that affect their ability to learn online? In a recent commentary focusing on current research in the area of technology-based learning Saljo (2004), who helped pioneer phenomenographic research into student approaches to learning, would seem to concur, calling for a greater clarity about, and effort to understand, how students conceive knowledge and approach learning in new and emerging technology-enabled contexts (p. 493).

2.6 SUMMARY AND IMPLICATIONS

What is known about the nature of learning in instructional contexts has been shaped by three major theoretical perspectives. Constructivism, the currently dominant perspective, rejects the notion of knowledge existing externally to the learner, and contends that understanding is constructed within the mind of the individual as a result of their needs, motivations and subjective interpretations of experience.

Although the use of computer technology within learning is of great interest across the educational field, it is something the constructivist movement is particularly associated with as many current technologies have properties consistent with constructivist principles. The potential benefits of educational technologies are often termed 'affordances'. Originally used within ecological psychology to describe the relationship between an individual and the opportunities for action perceived within objects in their environment, in relation to educational technology an affordance is the opportunity for extended learner capabilities that exist in the properties of a specific technology. With their single point of web access to an integrated range of tools and resources, the contemporary literature makes many claims about the affordances of NLEs. These include opportunities for the learner to study when most motivated, to learn in a needs-based manner, to have their understanding enhanced through multimedia, and to participate in more reflective forms of discussion than is possible face-to-face.

However, evidence for the effectiveness of learning via NLEs is varied. Comparisons of online with traditional course delivery indicate online learning is at least as effective in terms of outcomes. Furthermore attitudinal studies, which have been primarily quantitative, tend to find that most students value the opportunity for self-paced learning, appreciate the guaranteed completeness of information, and generally like the richer range of resources that NLEs feature. Yet at the same time only a small minority of students are fully at ease with the idea of working online. Many feel a strong need for face-to-face support, and find motivating themselves to study online difficult.

Research into use and perceptions of asynchronous discussion is more positive overall. Students generally like communicating in this way, and find it effective in enabling a reflective exchange of views. Several content analyses provide corroborating evidence for this. However, the key proviso is that there must be a purpose, typically a collaborative task, for students to engage with one another online. In the absence of a clearly communicated reason for participating in asynchronous discussion, few students do. This need for explicit instructional guidance is also a common theme within research into how effectively students interact with hypertext-based environments.

What these findings point towards is a disparity between what students like about networked learning, and how they undertake it in practice. A possible reliance on traditional methods of studying has been suggested. All this implies that many students do not interact with networked environments in the manner necessary to fully realise the potential educational benefits inherent within them. The repeated delay of studying arguably counters the opportunity for effective self-paced learning. Similarly, frequently reading offline mainly limits students to working with the materials they opt to print.

The fact that learners do not always interact with NLEs in optimum ways has a particularly serious implication for constructivist theory and research. This is in exposing the constructivist myth, at best assumption, of the compliant learner. Much of the constructivist literature, particularly on technology-supported learning, discusses the benefits of students interacting with environments designed around constructivist principles and technologies in terms that imply they will be experienced by all students. For a theoretical movement founded on the assumption that what we learn is a direct result of idiosyncratic needs and interactions with our environments, and which advocates giving students the freedom to make decisions about which resources to use and paths to take within educational environments, it is strange that little attention is directed towards the influence that individual ways of working might have upon how students interact with educational environments, and their resulting understanding. The failing of constructivist theory and research to fully address learner compliance and complacency has to date only been acknowledged by two or three key theorists.

Some insight into why students do not always utilise educational technology effectively can be gained from research into the influence of cognitive and learning styles, which indicates that students who can be categorised as more active, independent learners will tend to do better. However, such research is inherently limited by being largely quantitative, and using style measurements that relate to cognitive information processing ability, or preferences for learning in fairly general contexts. The problem with this, which also applies to the more relevant studies that use inventories relating to learning in conventional course contexts, is that the tools used to assess learning style differences are not sensitive to the nature and demands of networked learning. Furthermore by being mainly quantitative, research into individual differences and educational technology tells us very little about why students might utilise NLEs as they do. A similar criticism can be made of quantitative attitudinal research into networked learning, which provides basic information pertaining to what is positive and negative about the experience but gives scant insight into the actual experience from the subjective viewpoint of the learners themselves. Likewise experimental research into learning via supportive multimedia says nothing about how, or even if, students will interact with multimedia features integrated within autonomously accessible NLEs.

The implication of the literature review for this research then, as phenomenographic research into student learning in traditional courses convincingly illustrates, is that more qualitative-based research into the student experience of networked learning is required to understand more fully not just how students interact with NLEs, but also what intrinsic and contextual factors influence the nature of their interactions. This reflects a growing recognition within the field that research which focuses on the challenges students face in networked learning contexts, and how they respond to these demands, may be required to explain why students do not always make optimum use of NLEs, and to inform practice geared towards supporting more effective online learning.

3.0 METHODOLOGICAL APPROACH

This chapter describes the methodological approach taken to the investigation. Specific issues of reliability and validity are addressed where appropriate, while more general issues in this area are considered in the concluding chapter of the thesis.

3.1 RATIONALE AND OVERVIEW

3.1.1 RESEARCH RELEVANCE

The purpose of any social science research is "on *understanding* [original emphasis] something, gaining some insight into what is going on and why it is happening" (Maxwell, 1998, p. 74). The potential worth of research can be judged partially on the extent to which it enhances existing knowledge of a social phenomenon, particularly if that phenomenon is one about which little is currently known (Morse, 1994; Mason, 1996). The aim of this research is to arrive at an understanding of the diverse ways students interact with, and subsequently learn from, autonomously accessible NLEs that are the sole method of course delivery in campus-based higher educational contexts. The focus is principally on the idea of individual approaches to learning, the opportunities or affordances for enhanced learning that are thought to be inherent within NLEs, and those contextual factors, both instructional and relating to specific features of the environment, that influence the nature and effectiveness of networked learning.

Research in this area can be seen as worthwhile on a number of levels. At the broadest it is justifiable within the current climate of increasing interest in, and migration towards, technology-centric and online forms of learning. More specifically, and of significance given this climate, the foregoing literature review reveals that what we understand about how students interact with and learn from educational technology, particularly networked environments, is limited in a number of respects. Thus whilst there is evidence to suggest that the elements of NLEs can indeed support learning in the ways described in the contemporary literature, out with this realm of predominantly experimental research there has been little substantial attempt to determine if this holds true in networked contexts. The question is whether learners interacting autonomously with NLEs, and who are self-responsible for how, when and what they learn, do so in a manner conducive to realising the potential affordances inherent in the hypertext, multimedia, and asynchronous discussion features of NLEs. Little insight can be gained from research focusing on learning styles and interaction with educational technology. This is predominantly quantitative in nature, and although it suggests a probable link, findings are fairly inconsistent regarding learning style, technology, and outcomes.

The gaps in our current understanding about the nature and effectiveness of networked learning are largely attributable to a lack of research in one notable area - comprehending the experience of networked learning from learner's perspectives (Ward & Newlands, 1998; Windschitl, 1998; Angulo & Bruce, 1999; Goodyear et al, 2004). The argument is that until this is properly addressed, then we cannot fully understand the diverse ways in which learners undertake networked learning, the intrinsic and extrinsic influences that make this effective or not, or ultimately account for individual differences in learning outcomes. It is in recognising and attempting to address the lack of knowledge in this area that provides a rationale for, and relevance to, this research.

3.1.2 PARADIGMATIC ALIGNMENT

To be methodologically sound, the methodological approach taken within any investigation should be determined by the research paradigm with which the work is aligned. A research paradigm is "the basic belief system or worldview that guides the investigator, not only in choice of method but in ontologically and epistemologically fundamental ways" (Guba & Lincoln, 1994, p. 105). Ontology concerns the perceived nature of the phenomena or social reality under investigation, and an epistemology the form that evidence of the social reality under investigation will take (Mason, 1996, p. 11-13). Thus an investigator who from an ontological position views social reality as comprising individuals and their understandings and motivations might, from an epistemological position, view personal descriptions of belief as the most legitimate way to arrive at an understanding of the social phenomena being researched.

Within social science, the main research paradigms are the dialectically opposed positions of positivism and interpretivism. Positivism is "the view that social science procedures should mirror, as near as possible, those of the natural sciences" (Blaxter et al, 2001, p. 61). Known as the scientific approach for this reason, the essence of positivism is that social reality can be directly apprehended through controlled experimentation and quantitative data collection methods designed to test pre-defined propositions. The associated epistemology is objectivist in assuming that one true social reality exists and can be understood, and for believing "the investigator to be capable of studying the object without influencing it or being influenced by it" (Guba & Lincoln, 1994, p. 110). At the other extreme, the paradigm broadly referred to as interpretivism advocates a relativistic approach to comprehending social reality. Multiple ways of understanding and explaining social phenomena are pre-supposed at the outset, and seen as knowable through individual interpretations of experience, shared meanings, and social practice. Through employing qualitative methods that involve observation of and immersion in social situations, and which always include dialogue with the individuals in those situations, the interpretivist investigator aims to "elucidate the process of meaning construction and clarify what and how meanings are embodied in the language and actions of social actors" (Schwandt, 1994, p. 118). The associated epistemology is therefore subjective, relating in the first instance to the interpretations of the participants in the research, and then to those of the researcher.

The hallmark of interpretative approaches to social research is naturalistic inquiry, which is the prolonged study of phenomena as they occur within real-world contexts. Proponents view this as the only option for developing a deep understanding of social phenomena and the situational influences that shape them (Ely et al, 1991; Erlandson et al, 1993). As the antithesis of positivistic research, the intended outcome of naturalistic inquiry is not to explain phenomena in terms of the cause-effect relationships between variables, but to produce a detailed description of plausible patterns and themes. Such endeavour is of increasing interest in the field of technology-based learning. Neuman (1989) was amongst the first to advocate naturalistic inquiry in this area, stating that the most insight "will not come from examining individual pieces of the puzzle in laboratory settings, but from studying the entire picture within its natural environment" (p. 41). Other researchers have followed suit in arguing this point, and recommending various methods to use in further understanding how students learn with technology in natural contexts (e.g. Draper et al, 1996; Gunn, 1997; Oliver, 1997).

Due to the phenomena under investigation, the limitations of previous research it is intended to help address, and the main methods employed, this research should be seen as an interpretivist, naturalistic inquiry. From an ontological perspective the main assumption is that individual learners undertake and experience autonomous networked learning in diverse ways within the same context. From an epistemological perspective, these are deemed to be knowable mainly through subjective descriptions of practice and experience from the learners themselves.

3.1.3 PHENOMENOGRAPHIC METHOD

The main method of data collection in naturalistic research is the interview, as the main object of naturalistic research is the individual within a particular social context (Erlandson, 1993; Guba & Lincoln, 1994). This investigation is no exception, although a specialised interview-based methodology was employed as the primary method. Phenomenography can be defined as "the empirical study of the limited number of qualitatively different ways in which various phenomena in, and aspects of, the world around us are experienced, conceptualized, understood, perceived, and apprehended" (Marton, 1994, p. 4424). As a qualitative research method, phenomenography developed out of the previously discussed interview-based studies that first introduced the idea of deep and surface approaches to learning. Used almost exclusively within educational research, in recent years the phenomenographic method has provided valuable insight into such diverse issues as student revision strategies (Entwistle & Entwistle, 1991), their changing beliefs about learning resulting from engagement with traditional versus constructivist educational environments (Tynjala, 1997), and also practitioner perspectives of networked learning (Jones et al, 2000). It is the proven applicability of phenomenography to understand aspects of learning within higher educational contexts that makes it particularly appropriate for this study.

The starting point for phenomenographic research is an interview involving the researcher and, typically, the individual learner. The interview is semi-structured in so far as a list of issues pertinent to the area of interest is pre-prepared, with the point of the interview being to "establish the phenomenon as experienced and to explore its different aspects jointly and as fully as possible" (Marton, 1994, p. 4427). Most questions should follow on from what the participant says, with the researcher being responsible for prompting the interviewee to move from a position of unreflected to reflected awareness of their own experiences. The analysis procedure is rigorous and iterative. Interviews are transcribed verbatim, and in the first instance comments from individuals might typically be organised according to the general themes or issues covered in the interviews. This produces a pool of responses relating to each theme, and reflects the range of perceptions of the same phenomena. Further re-reading is undertaken in order to discover the underlying meaning of the thematic comments, at which point the critical attributes of groups of similar comments is considered. This facilitates the development of "categories of description" that reflect the various ways in which the same phenomena is experienced or understood. Logical relationships between categories of description are then conceptualised to form a hierarchical classification scheme termed "the outcome space", which is intended to reflect a natural order in the qualitatively different ways of experiencing a phenomena. The categories of description and outcome space are the end results of a phenomenography, and once finalised can be reapplied to the original data. It is then possible to return to the individual as the object of analysis to determine which classification best describes, for example, their own approach to studying (Marton, 1998; 1994; Marton & Saljo, 1997).

Criticisms of the phenomenographic method should be acknowledged at the outset. Ashworth & Lucas (1998) note the possible subverting influence of the researcher, and call for them to 'bracket' existing knowledge and beliefs lest the direction of the interview and subsequent analysis be distorted. This need is seen as being only implied within existing accounts of the method. Ashworth & Lucas also question the notion of there being a limited number of ways to experience phenomena, and lament the lack of guidance on how to close an analysis. Richardson (1999) considered the history and philosophy of the approach, and indicated that phenomenography might be seen as less of an idiosyncratic research endeavour by critics if findings were supported by data obtained through methods other than the interview alone. It is also widely observed that phenomenographic analysis produces categories of description one step removed from the original subjective perceptions. Thus it is possible that experience will be described in terms meaningful only to the researcher, and represent no recognisable reality to interviewees or other investigators (Ashworth & Lucas, 1998; Meyer, 1988, Richardson, 1999). The implications of these issues for this study are addressed where relevant.

3.1.4 GENERAL RESEARCH DESIGN

In striving for an insight into the nature and effectiveness of student interaction with NLEs, the basic research design comprised two case studies and what can be described as a 'naturalistic experiment'. The rationale was to study the phenomena of interest in real or, as regards the experiment, realistic contexts. In accordance with the research objectives a number of issues were of interest. At a general level, the first is the extent to which learners feel they do actually benefit from the affordances thought to be inherent in NLEs, so as to determine the educational potential of NLEs. In recognising the need to understand the wider context within any naturalistic inquiry, student perceptions of the instructional factors that influenced their interaction with NLEs were also considered relevant. The third and most important factor concerns the diverse ways in which individuals tended to approach networked learning, i.e. their networked learning 'style', and the influence this had upon learning outcomes. Finally, and also pertaining to context, because NLEs integrate several educational technologies within a resource-rich single environment, it was considered pertinent to investigate whether the constituent elements themselves have any influence upon interaction with NLEs.

Whilst phenomenography was the main method of inquiry, a number of additional, quantitative methods and data sources were used. Although associated with different research paradigms, naturalistic inquiry does not necessarily preclude the use of quantitative methods (Ely et al, 1991; Erlandson et al, 1993; Mason, 1996). The crucial point is "whether the combined measures are designed to reduce or expand the constructions of reality that are being considered" (Erlandson et al, 1993, p. 37).

Within this investigation the quantitative methods used were selected purely for the contribution they could make in enhancing or verifying the understanding achieved through the individual interviews, to which they were of secondary importance. The use of multiple qualitative and quantitative methods to study aspects of social reality characterises research in the post-positivist tradition. Like positivism the post-positivist position is also concerned with objective truth, but holds that this is only partially knowable "because all methods are flawed" (Denzin & Lincoln, 1994, p. 15). Although this research is fundamentally interpretivist in nature, the use of multiple methods to garner as full an understanding as possible, albeit still a subjective one, could be regarded as a post-positivist strategy. In selecting the research and data collection methods, both qualitative and quantitative, much consideration was given to their validity and reliability. Depending upon if the chosen methods are quantitative or qualitative, these issues are judged very differently. However the general concern was with whether the methods were valid in that they actually related to, or measured, the issues being explored, and were reliable in that their use in a similar setting and context, with the same focus, could produce similar results (Blaxter et al, 2001, p. 221).

Given the topic of interest, it was felt the success of the investigation would partially depend on the learners involved possessing a competent level of IT literacy. Arguably any technological barrier that exists for the learner would have major implications for understanding the nature of autonomous networked learning, and for this reason it was decided to purposively involve learners who were familiar with using information technology. Prior experience of networked learning was not a consideration. As previously indicated, the type of NLEs of interest were those combining hypertext-based course material, supportive multimedia, and asynchronous communication facilities, and that were the sole or primary method of course delivery. Data collection was carried out over two periods. The first case study and the naturalistic experiment were conducted during semester two of the academic year 1998/1999, and at the institution of the investigator. The second case study was conducted over semester one and part of semester two of the year 1999/2000, and located at another institution. Learners received a small nominal fee to participate in the research. Although not normally recommended (Draper et al, 1996), this was considered appropriate given the duration of the commitment that was required. Because of the analysis requirements, it was necessary for names to be recorded at each stage of data collection. Strict confidentiality was guaranteed, and appropriate measures taken to ensure the secure return of data collection materials. This was considered crucial to ensuring the full co-operation of participants, especially in the case studies where there would naturally be a concern about course tutors gaining access to critical feedback (Harvey, 1998).

3.2 CASE STUDY RESEARCH

3.2.1 PURPOSE

Stake (1994) describes case studies as essentially being about a choice of object to be studied, and what that object, or case, can tell us about the nature of the behaviour or phenomena that occurs within specific situational boundaries. For Yin (1994) the case study is the preferred strategy for naturalistic research "when how or why questions are being posed, when the investigator has little control over events, and when the focus is on a contemporary phenomenon within some real-life context" (p. 1). These criteria respectively apply to the objectives, conditions, and focus of this particular study, which seeks to understand how students approach networked learning. As this naturally occurs within the situational boundaries of real-life educational contexts, case studies involving genuine networked courses seemed the most viable research method.

Although often discussed in terms of being a data collection tactic or methodological design feature, the case study can also be seen and used as an all-encompassing strategy to guide an investigation from conceptualisation through to data collection and report writing (Yin, 1994; 1998). Many of the stages in the case study-as-strategy approach, including defining the area of research, selecting appropriate cases, and identifying data collection and analysis methods, are naturally also central to this research. However there are important points of departure. Incompatible is the emphasis placed on developing at the outset a theory to be tested, and the conventions advocated for analysing and reporting data - many of which are positivistic in nature. Particularly problematic is the assertion that the accuracy of verbal reports must be verified through other sources of data "before they can be accepted as valid" (Yin, 1998, p. 247). For these reasons, and the fact this research also involves an experimental element, the purpose of the case study method within this investigation is as part of the overall methodological approach. Specifically it is the means by which naturalistic inquiry into real-life networked learning contexts, through selection of suitable cases, is facilitated.

3.2.2 SELECTION OF CASES

Stake (1994) differentiates between three main types of case study. An intrinsic case study is one undertaken in order to better understand a specific case object, whether that be an individual, organisation, or micro-level social context. The case itself is the focus of the investigation, rather than any generic phenomena. In an instrumental case study "a particular case is examined to provide insight into an issue or refinement of theory" (p. 237). In this respect the case itself is of secondary interest, chosen because it is expected to advance our understanding of some phenomena. The third type is the collective case study. This spans multiple instrumental cases across which there may be similarities and dissimilarities pertaining to the phenomena of interest, with each case chosen "because it is believed that understanding them will lead to better understanding, perhaps better theorizing, about a still larger collection of cases" (p. 237).

For this research a collective case study involving two real-life courses was undertaken, and considered appropriate for several reasons. Firstly, at least one suitable instrumental case study was required to facilitate investigation into the phenomena of interest. Unfortunately it became apparent at the outset that very few networked courses, at least of those within reasonable logistical reach, featured NLEs that possessed all the constituent elements of interest, and which were also the sole or primary method of course delivery. Arguably this reflected the state of the art at the time the potential case studies were being sought. An extensive analysis of several hundred NLEs was published towards the end of 1999, and this certainly highlighted the small number of resources that featured hypertext course material alongside supportive multimedia and asynchronous discussion facilities (Mioduser et al, 1999). Therefore to ensure that all the factors of interest were investigated in genuine networked learning contexts, a collective case study was the only option. Two case studies were selected because it was felt that, in addition to the naturalistic experiment, this number would enable the investigation to be thorough whilst manageable in breadth and depth.

3.2.3 CASE STUDY 1: HUMAN FACTORS MODULE

The first case study involved a final year cohort of undergraduate Information Management students at Queen Margaret University College, Edinburgh, interacting with a NLE to undertake a core module titled Human Factors in Information Management. This module covered topics including cognitive and physical ergonomics, politics of training, and human factors policy in organisations. Learning was primarily co-operative and problem-based, and geared towards completing four assignments due for submission at various points throughout the module. For the first assignment learners were allocated to groups and required to collaborate in producing a written solution to a hypothetical human factors problem. For the related second and third assignments learners were reallocated to different groups and assigned a case study of human factors practice within a real organisation. An individual report of the perceived key issues for the case constituted the second assignment, whilst the third assignment involved the group visiting the organisation in question and collaborating to produce a digital documentary of their findings. The digital documentaries of each group were posted on the NLE near the close of the module, and for the fourth assignment individual learners were required to peer assess those of the other groups. Ultimately the aim of the work undertaken on the module was for learners to develop the ability to think and collaborate in the manner required of actual practitioners.

3.2.4 CASE STUDY 1: NETWORKED LEARNING ENVIRONMENT

The material within the Human Factors in Information Management Learning Environment (HFIMLE), which was the sole method of course delivery, was organised into several sections containing material required for one or more of the assignments.

<u>Problem Space:</u> This presented the scenarios describing specific human factors problems that were to be the focus of collaborative activity for the first assignment. In an example scenario, one group was required to produce and justify a design outline for a computer lounge for a specific student group in a higher education institution.

<u>Theory Base:</u> This was sub-divided into five sections, one for each topic area covered on the module. Each section contained study notes to introduce the general topic and key concepts, a reference list of relevant print-based materials, journal article abstracts, and an extensive list of links to further reading located on the web. In addition to using the external links, students were encouraged to use the web to source further background reading and find material that could be used for specific assignments.

<u>Case Base:</u> This contained the organisational case studies that formed the basis of work undertaken for assignments two and three. Each case comprised a transcribed interview with the member of staff responsible for human factors practice and policy, with the case transcript sub-divided into sections reflecting the module's five main topic areas.

Admin Space: A weekly schedule indicating which activities students should be working on at specific points, and the deadlines for the respective assignments, formed the main content. Links to detailed assignment specifications describing procedure, mark allocation, and collaborative group members were also provided.

The HFIMLE did not feature supportive multimedia, but in addition to the extensive course materials described it did provide asynchronous communication facilities.

Conference Space: A computer conferencing facility utilising Netscape Newsgroups. This was to be used specifically in relation to the first assignment to facilitate discussion and production of the final written solution. All collaborative activity was to occur online, including the allocation of work and distribution of draft report sections for review and feedback. Through stipulating this condition, the tutor was able to assess the contribution of each individual to the problem solving process. The facility was also intended to be used more generally to "allow active discussion between students and lecturers on subjects which are relevant to the module" (excerpt from HFIMLE).

E-Mail: Students were encouraged to use e-mail to contact the lecturer and additional tutors with any assignment or subject-related queries, and e-mail links were provided at pertinent points throughout the HFIMLE. They were also given the option of using e-mail to collaborate with one another generally, and in relation to the group problem solving assignment provided that they copied any e-mails to the principal lecturer.

3.2.5 CASE STUDY 1: PARTICPANTS

The total student cohort numbered thirteen, one of whom later withdrew from the degree course. Of the remaining twelve, ten agreed to participate in and completed the study. Eight participants were female. Six participants were under the age of 30 years, mainly in their early twenties, with the remainder between 31 and 50 years. Seven accessed the HFIMLE solely or mainly whilst on campus, and three mainly from home.

As the participants were final year Information Management undergraduates, a high level of general computer literacy could be assumed. Accordingly eight participants self-rated themselves as either skilled or expert in wordprocessing, using windows operating systems, and in information searching via online and CD-ROM databases. The remaining participants considered themselves intermediate in each of these areas. A similar split in ratings applied to using web browsers, search engines, and e-mail. On using online discussion facilities, six rated themselves as limited or intermediate.

Prior educational experience was varied. Only two participants had begun the Information Management degree straight after high school, whilst the remaining eight all had prior experience of further or higher education. This reflects the high number of mature students and direct entrants from HNC and HND courses that the course attracted. In relation to learning with technology, all participants had previous experience of accessing web-based course materials, searching the web for information/further reading materials, and using e-mail for contacting tutors and peers. Many had used also computer conference facilities for seminar-style discussion. However, none of the participants had prior experience of interacting autonomously with NLEs that were the sole source of instruction. At the start of the module, all students attended an introductory workshop covering the purpose, features and use of the HFIM LE.

3.2.6 CASE STUDY 2: CARBOHYDRATE CHEMISTRY MODULE

For the reasons previously outlined, identification of a second case study proved problematic. One that did feature an appropriate environment used as the sole method of course delivery was identified, only for access to be withdrawn after much of the preparatory work had been completed. An alternative case study was arranged. It did not fully satisfy the selection criteria, but was not an unsuitable option and, in addition, facilitated investigation into a number of factors not covered within the first case study.

The case study comprised a third year organic chemistry module that was compulsory for several undergraduate programmes within the Department of Pure and Applied Chemistry, University of Strathclyde. The module was split in two halves. The second half covered the subject carbohydrate chemistry, concerning the molecular structures and reactions of simple carbohydrates. Whilst the first half of the module was delivered via lectures alone, the second was delivered via lectures and a NLE. Although the lectures for Carbohydrate Chemistry ran during the final six weeks, the Carbohydrate Chemistry Website (CCW) was available from the outset of the module. The resource could be accessed from home and any on-campus IT lab. In addition, a dedicated lab was reserved for the first six weeks of the module to guarantee access to the resource prior to the lectures commencing. One important feature of the CCW was that the browser toolbar was disabled upon entering the environment; a deliberate strategy intended to ensure all learning took place online. The CCW is housed within Clyde Virtual University, a web-based platform for delivering online facilities shared by the main universities in Glasgow. Clyde Virtual University and the resources it contains are described at length elsewhere (Littlejohn & Slater, 1999; Whittington et al, 1999).

Self-study via the CCW was optional, but strongly recommended to the students on the grounds that the material and features within the environment complimented and expanded upon the lectures. The environment was expected to be the main source of learning for the majority of the students. Beyond the CCW and lectures, formal seminars were held on two occasions in order to revisit the content of the entire module. In practice there was considerably less coverage of the carbohydrate chemistry subject area, which was partially deliberate because much of the student-student and student-tutor discourse on this subject was intended to occur via the CCW's discussion facility. Assessment was via an end of semester written exam. Students were required to answer four out of six questions. There were three questions for each half of the module, although the student was free to select how many they answered from either area.

3.2.7 CASE STUDY 2: NETWORKED LEARNING ENVIRONMENT

The main sections of course and related materials within the CCW are described below.

<u>Information:</u> This briefly explained what the CCW was and described, in varying levels of detail, the main features of the resource and how they were to used and operated.

<u>Course Material:</u> Comprised four separate sections of material that complemented the basic lecture content, but went into more detail and used more examples. The sections were: introduction to carbohydrate chemistry, neighbouring group effects, protecting

groups, and glycoside synthesis. The introduction covered the pre-requisite knowledge for the remaining sections, which were intended to be undertaken in the above order.

Glossary: An alphabetical index of key terms and definitions accessible from any page.

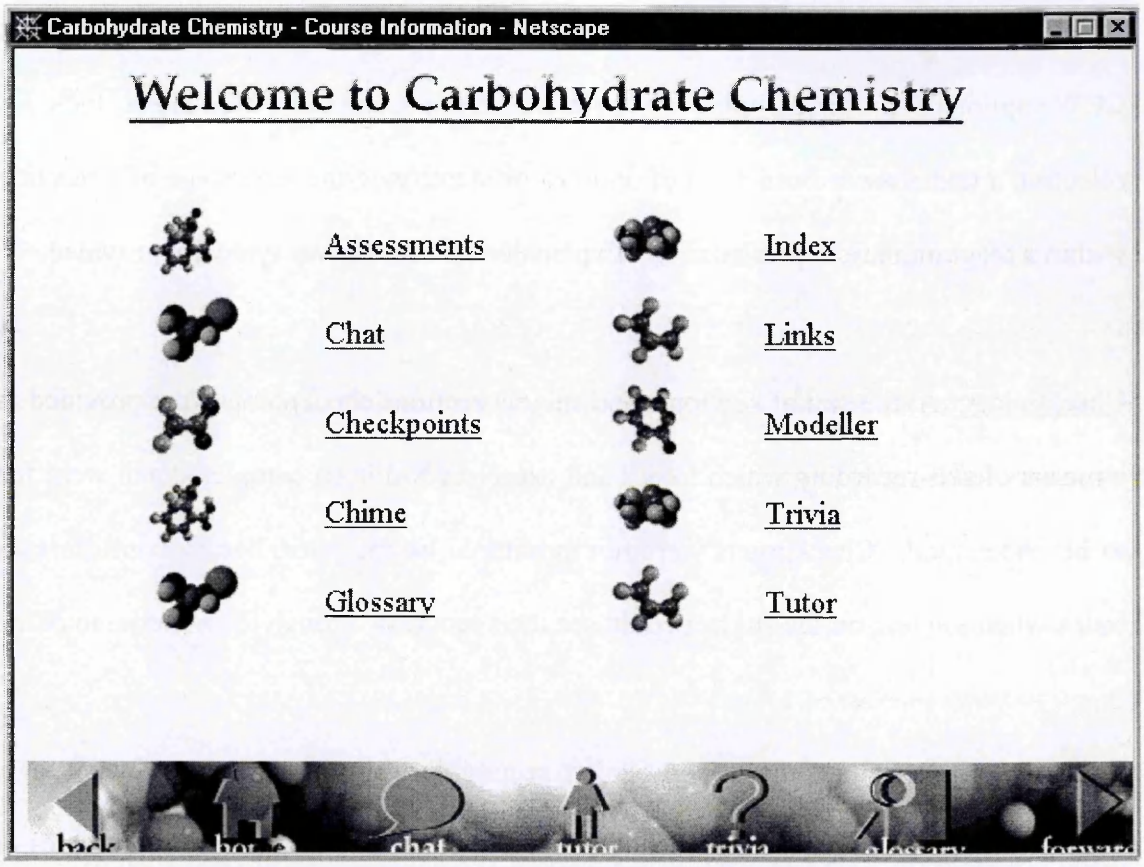
Interesting Links: An extensive list of links to external web sites, with content varying from online textbooks and journals to further readings on topics covered in the CCW. This page could only be accessed by following a link provided on the home-page.

In addition to the informational content, the CCW featured a range of additional tools and interactive elements intended to enhance the learning experience in numerous ways.

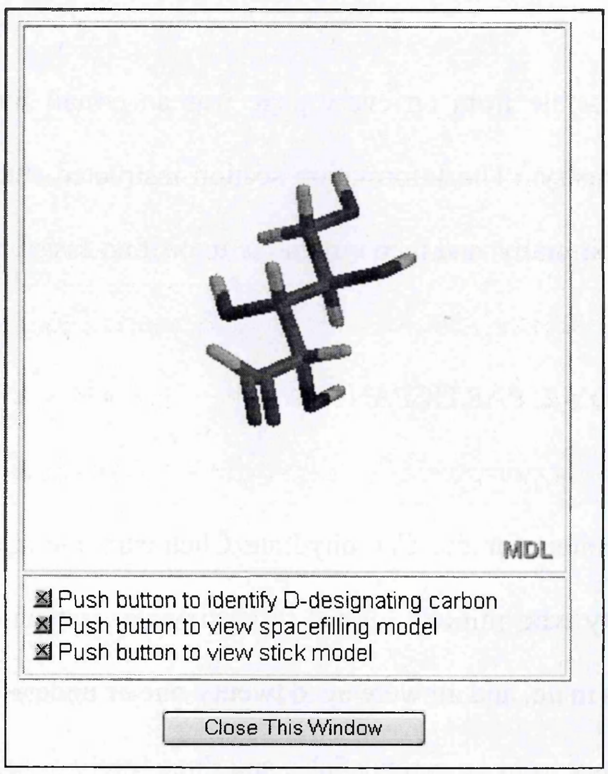
Interactive Diagrams: Supplementary to the static diagrams of molecules and reactions that are standard presentational formats within chemistry, the CCW also included interactive versions. On positioning the pointer over specific parts of a diagram, either an explanation of that element would appear or the structure itself be further expanded.

Chime Models: Three-dimensional chemical structure models that could be rotated and manipulated via the mouse. Presented by default in the ball and stick format of a traditional plastic model, other display options included labelling and wireframe format. Intended to aid with visualising of molecular structures (see example on next page).

Chemical Modeller: A chemical drawing tool embedded within specific pages, and which allowed the learner to draw structures in response to certain questions. Upon clicking 'submit', the drawing was assessed and feedback provided momentarily.



SCREENSHOT: The Welcome menu for the Carbohydrate Chemistry NLE.



Chime models similar to the one depicted above featured

heavily throughout the Carbohydrate Chemistry Website

Assessments: In addition to the chemical modeller, at various points throughout the CCW optional, multiple-choice style tests were presented. Variations included selecting a text answer from a list of options, or identifying the next stage of a reaction within a diagrammatic representation. Explanatory feedback was typically provided.

Checkpoints: At the end of key topic and subject sections checkpoints were provided as a means of self-recording which topics and exercises had been completed and were felt to be understood. Checkpoints were not monitored by the tutor, but by consulting an index when logging on the student could see their progress through the material to date.

Chat: An asynchronous discussion facility accessible from the toolbar on every page. This was intended to facilitate student-student and student-tutor discussion on topics of interest. As with their general use of the CCW, student participation in discussion was not assessed although they were instructed to ask questions and post-responses freely.

E-Mail: Also accessible from on every page was an e-mail link to the lecturer for Carbohydrate Chemistry. The Information section instructed students to raise queries via the Chat facility initially, and then e-mail the tutor if no assistance was forthcoming.

3.2.8 CASE STUDY 2: PARTICPANTS

The total student cohort for the Carbohydrate Chemistry module numbered seventy-nine. Of the twenty who initially agreed to participate, sixteen completed the study. One participant was male, and all were aged twenty-one or under. Thirteen accessed the CCW solely or mainly from on-campus labs, and three solely or mainly from home.

Unlike case study one, a high level of general computer literacy could not be assumed and subsequently the participants were more varied in this respect. Around half considered themselves intermediate in wordprocessing, using windows-based operating systems, and information searching via online and CD-ROM databases, with the remaining half generally split between limited and skilled. Even more varied were levels of internet literacy. Five indicated they had either zero or limited experience of using a web browser, with the rest rating themselves as intermediate or skilled. Regarding search engine usage, there was an approximate split between those with zero or limited experience, and those considering themselves intermediate or skilled. Finally, whilst thirteen felt they were intermediate or skilled in the use of e-mail, nine participants possessed zero or limited experience of using online discussion facilities.

General educational experience was uniform. All participants had began their course straight from school, and so had no interim experience of further or higher education. Within the context of their undergraduate studies to date, approximately half had accessed web-based course materials and undertaken web searches for further information. Four had utilised e-mail for tutor contact, and thirteen for student contact. Only two had been involved in on-line discussions for specific modules. None had any prior experience of autonomous networked learning. At the start of the semester the majority had attended an optional introductory workshop on how to use the CCW.

3.3 THE NATURALISTIC EXPERIMENT

3.3.1 PURPOSE

Naturalistic experimentation has been a part of phenomenographic research into student learning since the original Marton & Saljo experiments (1976a; 1976b). Lest the terms 'naturalistic' and 'experiment' seem incompatible, all the phrase reflects is an attempt to create comparatively natural conditions under which to facilitate research into a particular aspect of student learning, with the principle research method always the phenomenographic interview (Marton, 1994; Entwistle, 1997; Marton & Saljo, 1997).

The purpose of the naturalistic experiment conducted as part of this research was two-fold. Primarily, it was seen as an appropriate means of investigating the potential influence that the constituent elements of a NLE have upon how learners interact with NLEs. As previously observed, NLEs are hybrid environments that integrate several resources within one environment. In attempting to understand the diverse ways in which learners interact with NLEs in natural contexts, it was therefore considered pertinent to try and understand whether the mix of constituent elements has any influence upon how individuals attempt to learn from NLEs generally, and mediated course materials specifically. Secondly, it was realised that by imposing some simple experimental conditions a useful insight into any contextual relationship existing between individual approaches, constituent elements, and learning outcomes might be provided. As it is reasonable to assume that different learners undertake networked learning variously across contexts, and because the features of NLEs can vary across contexts, a small naturalistic experiment was seen as further justifiable for this reason.

3.3.2 DESIGN

To facilitate naturalistic conditions, it was decided to purposively select a particular group of learners and design a NLE around a topic relevant to their own studies. A second year undergraduate Information Management cohort, based at the institution of the researcher, was chosen. In their third year these students are required to complete a core module in Human-Computer Interaction, which basically deals with issues in cognition, interface design, and computer usability. One small part of this module addresses the issue of colour and visual perception, although not in great detail. Expanding upon this topic to form the basis of the experimental NLE therefore presented itself as an ideal solution. By designing the NLE around a subject area complimentary to an upcoming module, the intention was to provide the participants with material they had a genuine academic interest in or reason for learning. This would hitherto seem to have been overlooked in much experimental work. Also, by basing content on a complimentary rather than directly assessed topic those who opted not to participate would not have been subsequently educationally disadvantaged.

The content of the material developed for the experiment was largely derived from the text and static images in a print and CD-ROM based teaching resource titled Colour in Computer Graphics by Professor Lindsay MacDonald (1996). The researcher, who has worked and taught in the area of Human-Computer Interaction, developed all additional content [1]. To ensure that the researcher had adapted the source material in a way that made pedagogic sense, the original author acted as reviewer. To facilitate investigation into the factors of interest, the researcher created four versions of the Colour in

[1] As well as ensuring that the researcher was familiar with the topic for which he was developing a NLE, this background was useful in designing a NLE, and selecting those for the case studies, that did not present any major barriers to learners in terms of their user-friendliness.

Computer Graphics Website (CCGW). All had identical textual content, but differed according to the presence of supportive multimedia and asynchronous conferencing:

- CCGW 1 – Text with supportive multimedia and asynchronous conferencing
- CCGW 2 – Text with asynchronous conferencing
- CCGW 3 – Text with supportive multimedia
- CCGW 4 – Text only

Participants were assigned to using one version of the environment for the duration of the experiment. There was no allocation procedure, and participants were simply distributed amongst the environments as they signed up for the experiment. The experiment ran for six weeks, and basically took the form of a short module split into three two-week blocks. At the start of each fortnightly period the students were required to commence learning a new section of the subject material. To reflect naturalistic conditions of autonomous networked learning, the only stipulation was that they made a reasonable attempt to learn the material as best they could. When and how long they studied for was completely at their own discretion. At the end of each two-week block the students assembled to complete a brief knowledge test.

To provide a purpose for learning other than the periodic assessments, for each two-week block there was an associated learning activity. Typically this involved identifying a real-world example of colour use, often via the web, that exemplified what the participants were currently studying. Depending upon their experimental group, the students presented their examples to fellow students online, or to the researcher via e-mail. The researcher assumed the role of tutor within the experiment, essentially to deal with any subject-related questions or difficulties the participants were having in learning the material. As well as providing a source of support present within any natural networked learning context, this meant the researcher would be in a position to hopefully identify and then account for any major recurring problems.

Besides being assigned to different versions of the CCGW, and having autonomous control of their own learning, three further experimental conditions were imposed upon the participants. Each version of the CCGW was password protected, and the first condition was that they did not disclose their password to any other individual, participant or not. The second condition was that they did not discuss the topics being studied with anyone else involved or out with the experiment, unless they were using an environment that featured an asynchronous discussion facility. The final condition was that participants did not, during the experiment, seek to enhance their understanding by consulting print or online materials out with the environment they were assigned to. It is for this reason that none of the environments featured a list of external links so common within NLEs. The purpose of these conditions was to ensure that any perceived or formally assessed learning outcomes where wholly attributable to the environment used, and the manner in which it was used by individual students.

The design of the experiment could be critiqued on the grounds that participants interacting with more sophisticated versions of the environment, especially those featuring supportive multimedia, could be said to be at an educational advantage. Whilst this is accepted, the counter argument is that we know very little about the role constituent elements play within autonomously accessible NLEs. Multimedia may well enhance learning when featured within a NLE, but perhaps in an otherwise equivalent environment any influence the absence of multimedia has upon learning outcomes is countered by the opportunity for self-paced studying. In addition, it could be that a far more prominent influence on learning outcomes is how the individual approaches networked learning generally, not the specific features within the environment.

3.3.3 THE NETWORKED LEARNING ENVIRONMENT

The material common to all versions of the CGCW comprised the following:

Home: An informational home page describing the purpose of the environment, and providing an overview of the content for that particular version of the CCGW.

Outline: A breakdown of activity for the six-weeks of the study, detailing the material and activities to be undertaken, dates and locations for the fortnightly knowledge tests, and instructing students to use e-mail freely to contact the tutor as required.

Theory Base: Comprising the theoretical material to be studied split into the fortnightly topic areas: colour vision and perception, using colour effectively in computer displays, and colour in the human-computer interface. Intended to be followed sequentially.

Glossary: An alphabetical index of key terms and their definitions. Accessible from the navigation bar on each page, and also keyword links throughout the text itself.

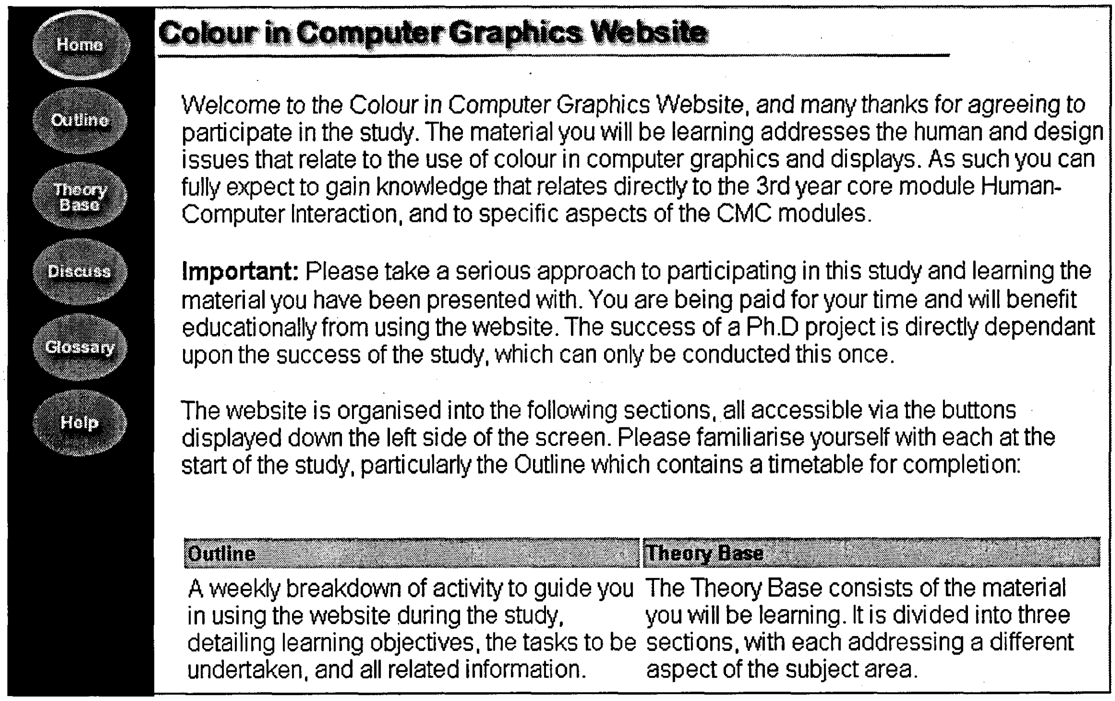
Help: A general help page covering how to obtain tutor assistance, navigating the resource, and technical issues relating to the optimum viewing of the site.

In addition to the standard informational content, the following constituent elements varied across the different versions of the CCGW environment as previously indicated:

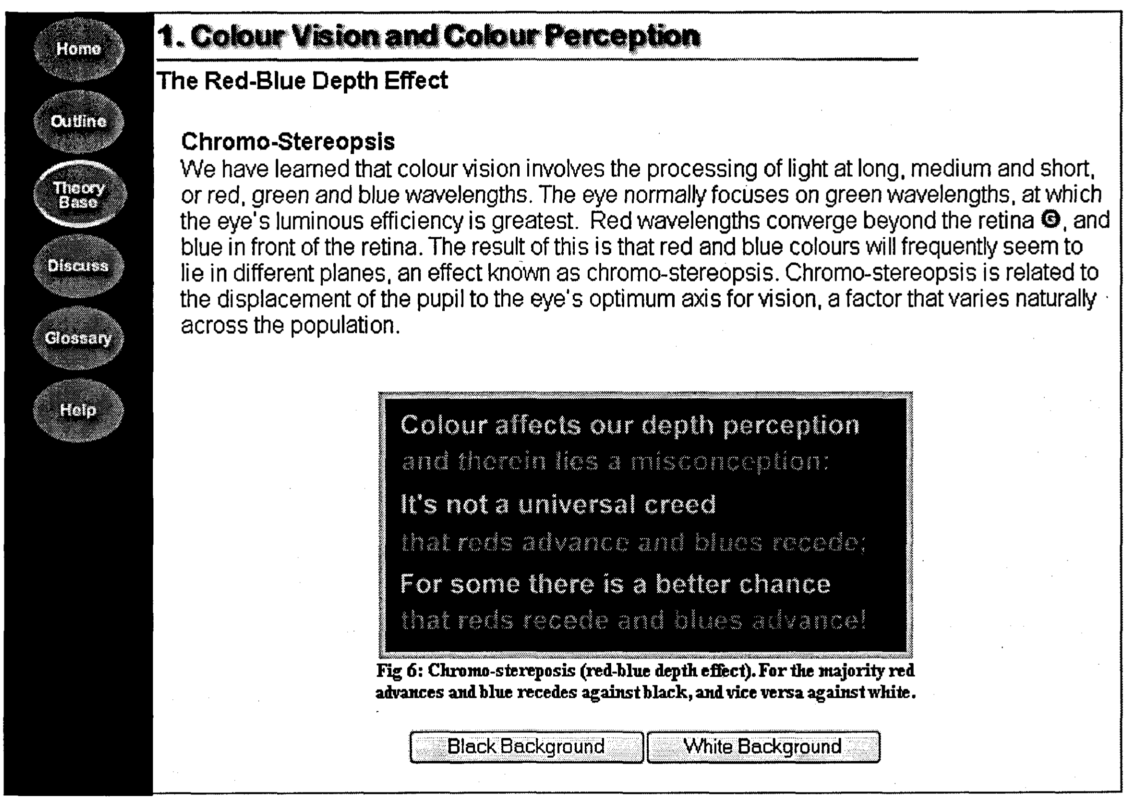
Discussion Area: An asynchronous conferencing facility featured in CCGW 1 and CCGW 4. This had a dual purpose. It was to be used to describe and discuss the examples of colour in computer graphics identified as part of the practical activities, and also as a general platform for subject-related discussion amongst the participants.

Supportive Multimedia: Featured in CCGW 1 and CCGW 3. This took the form of static images and graphics, animations, and interactive graphics allowing the user to click a button to alter their form (an example is shown on next page). The purpose of the supportive multimedia was to provide examples of what was being described in the text, the content of which they therefore complimented rather than extended.

E-Mail: All participants were instructed to use e-mail freely to raise any questions or queries they might have with the tutor, and tutor e-mail links were provided throughout each environment. Those without access to a Discussion Area were required to post their practical activity answers to the tutor. The tutor then provided brief feedback to confirm their understanding or point out any fundamental misunderstandings.



SCREENSHOT: Homepage for one version (CCGW1) of the Colour in Computer Graphics Website that was developed for the experimental study.



SCREENSHOT: An example of the supportive multimedia that featured within two versions of the Colour in Computer Graphics Website (CCGW1 and CCGW3).

3.3.4 PARTICIPANTS

The second year Information Management cohort from which participants were to be drawn numbered twenty-three. In lieu of being able to source any formal guidelines for selecting participant numbers for naturalistic experiments of student learning, the literature on conducting user evaluations of computer applications was consulted. This suggests between four and five users per application is optimum (Virzi, 1992). Based on this, and the number of students within the total cohort, five learners for each version of the CCGW was deemed sufficient. Eighteen students initially agreed to participate in the experiment. As a measure against withdrawals, and to meet the desired numbers, the first year of the same degree course were approached. This raised the number of participants to twenty-one, from which there was one subsequent withdrawal. In the end five participants used CCGW 1, five CCGW 2, six CCGW 3, and four CCGW 4.

Thirteen participants were female, seven male. Thirteen were under 21 years, four between 21 and 30, and the remainder between 31 and 50. Seventeen accessed the environment solely or mainly from on campus, and the rest solely or mainly from home.

As with case study one, the degree course of the participants assured a high level of general computer literacy. Nine rated themselves as intermediate on wordprocessing, and the remaining eleven either skilled or expert. A similar split related to using windows-based operating systems. Regards internet literacy, eight rated themselves as intermediate and twelve either skilled or expert in using a web browser. A similar split related to using a search engine. Almost all participants considered themselves skilled or expert with e-mail, and all but two had used online discussion facilities.

General educational background was varied. Eight had begun their degree course from school, and eleven had previous experience of studying at either further or higher educational level. Almost every participant had accessed web-based materials, searched the web, and used e-mail for both tutor and student contact as part of their studies. Eight had used online discussion facilities in this context. None had any prior experience of interacting with an autonomous NLE as the sole method of course delivery. All attended introductory sessions relating to their specific environment.

3.4 PRINCIPAL DATA COLLECTION AND ANALYSIS METHODS

The following describes the main data collection methods and their related analysis procedures. Unless otherwise indicated, these were used across all three studies.

3.4.1 EDUCATIONAL EXPERIENCE QUESTIONNAIRE

Prior to commencing their networked learning, participants were required to complete an educational experience questionnaire. This was in four sections. The third section concerned general computer literacy and educational experience, and included questions pertaining to any prior use of networked technology within formal educational contexts. The fourth section concerned general details such as age and gender. Questions in these respective areas were important to form a general picture of who the participants were, and whether they possessed the necessary technical skills to ensure that regardless of how individuals approached networked learning, all were minimally equipped to do so.

Appendix I shows the educational experience questionnaire for the human factors case study, although the design of this tool was standard across all three research contexts.

3.4.2 APPROACHES TO STUDYING INVENTORY

The first two sections of the educational experience questionnaire comprised questions derived from the latest version of the Approaches to Studying Inventory (Tait et al, 1998a). As previously discussed this principally measures, amongst other factors, whether a student takes a deep, strategic or surface approach to learning within higher educational contexts. Questions in the ASI take the form of five-point Likert statements with answers ranging from 'strongly agree' to 'strongly disagree'. Responses to individual statements are scored from 5 points for 'strongly agree' through to 1 point for 'strongly disagree'. By combining scores on groups of related statements, called scales, scores supposedly reflecting specific learner traits or characteristics can be determined.

The first section of the educational experiences questionnaire utilised a short-form version of the ASI that contained the statements relating to traits most consistently found to be associated with the deep, strategic and surface approaches to learning (Tait et al, 1998). Short-form versions of the ASI, derived from various incarnations of the full inventory, have been subjected to a range of statistical tests of reliability and validity by independent researchers. One such analysis by Duff (1997) provided evidence of moderate to high internal reliability, meaning the scales that should correlate do correlate. Regarding the issue of construct validity, or the extent to which the inventory does actually measure the abstract concepts it is designed to, Richardson (1990) concluded that the ASI "provides direct information about the approaches to learning that are adopted by students" (p. 165). Statements within the ASI are randomised rather than grouped together within their scales, lest the respondent deliberately tries to provide consistent answers on related questions. This convention was subsequently followed within the short-form ASI that was utilised.

The actual purpose of the ASI within the investigation was to provide an insight into how participants typically approached studying on their degree programmes, and accordingly they were asked to respond with this general context in mind [2]. It was reasoned that how an individual typically approaches studying may influence their approach to and perceptions of networked learning, a rationale that is presumably shared by the wealth of research to date that has utilised existing learning style measures in relation to student use of educational technology. As for why the ASI was chosen as a measure of learning style, there are two reasons. The first is that the tool developed out of phenomenographic research into student learning. In this respect it is consistent with, and can confidently be used alongside, the phenomenographic interview method. The second reason is that the ASI has proven to be more reliable than other inventories that are more frequently used in studies of technology-based learning. Newstead (1992) found it was far superior to the Kolb LSI, and it has been observed that the ASI is associated with "a depth of empirical support not so immediately obvious for many models of learning style found in the literature" (Riding & Rayner, 1998, p. 61).

The second section of the educational experiences questionnaire contains eight Likert statements from the ASI that relate to preferences for different types of course and teaching. Responses to specific items can be combined to provide scores on two scales. One concerns a preference for courses that support understanding, and the other for courses that transmit information. These traits are most often associated with the deep and surface approaches respectively. Because networked learning is arguably more understanding than transmitting orientated, these questions were included to provide an additional insight into how suited to networked learning an individual learner might be.

[2] Clearly indicating the educational context of interest is crucial to using the ASI effectively (Gibbs, 1992)

Appendix II contains a version of the educational experience questionnaire for the human factors case study with the ASI questions grouped within their scales, rather than randomised, to illustrate the short-form version of the ASI that was employed. The full ASI from which the short-form version was derived is shown in Appendix III.

3.4.3 POST-EXPERIENCE QUESTIONNAIRE

At the conclusion of the networked learning experience, a post-experience questionnaire was administered. This contained four sections, and although the specific content varied across the case and experimental studies, the basic content remained constant.

The first section concerned issues of general access to the NLE being used, such as whether access was from campus or home, the average weekly time spent reading the core materials, and whether and why learning took place predominantly on-line or off-line. Questions in this area were intended to provide necessary background information relating to the frequency and nature of learner interactions with their respective NLEs.

Because phenomenographic research has shown that how a student undertakes learning can be influenced by what they perceive as the purpose of learning within a particular context, the post-experience questionnaire contained a number questions that addressed the purpose of the NLEs and their constituent elements. The second section of the questionnaire required the student to indicate, via five-point Likert statements, what they thought was the general intended purpose of the environment they utilised.

The third section of the post-experience questionnaire was the main one, and contained a randomised list of Likert statements relating to perceptions of both the NLE and the networked learning experience. Questions were devised as a series of scales in so far as several questions relating to aspects of the same phenomena were identified, but without the intention of producing individual scale scores [3]. Common scales within each version of the post-experience questionnaire included 'pedagogical value of materials', 'changed role of learner', and 'networked learning value'. Respectively these contained items on the clarity of the theoretical materials, the demands of learning in a networked context, and how generally beneficial networked learning was found to have been.

In addition, there were a number of scales relating to the non-hypertext features of the environment in question. There were three scales per constituent element, each concerning the perceived purpose, usage, and value of that element. Respective items in each scale for supportive multimedia concerned, for example, whether graphics were seen as integral part of the material to be studied, whether all the graphical representations were studied, and the ways in which graphical representations were perceived to aid comprehension. The questions asked in section three of the post-experience questionnaire were intended to provide a general indication of what learners perceived to be the point of interacting with the respective NLEs, how they did actually interact with them, and whether they benefited educationally from the affordances inherent in NLEs and their constituent elements. This section of the post-experience questionnaire was also the most context-sensitive. Thus, for example, the version for the HFIMLE contained no scales on supportive multimedia as this was not a feature of that environment. Similarly there were four versions used in the experimental study, differing only in the inclusion or exclusion of scales on multimedia and asynchronous CMC. It became apparent during case study two that the computer conference facility

[3] This would imply the development of an inventory, which was beyond the scope and means of this study.

was being under-used, and therefore the contextual nature of selected items pertaining to asynchronous CMC was reflected in a focus on this non-use.

The final section of the questionnaire addressed perceived learning outcomes, and participants were asked to rate their confidence in each of the subject areas covered within the NLE. They were also asked to rate their level of general internet literacy via questions identical to the educational experience questionnaire. Participants in case study two were also asked to rate the NLE in comparison with the lectures received.

The post-experience questionnaire completed by the students who interacted with the 'full' version of the experimental study NLE is shown in Appendix IV. Appendix V contains a version of this with related questions grouped into their relevant 'scales'.

In investigating student perceptions of learning with technology, questionnaires are limited in that they provide only a basic indication of opinion as opposed to an in-depth insight, but are useful in that they guarantee some data on a range of relevant issues (Harvey, 1998; Oliver & Connole, 1998). With in-depth qualitative data being obtained through the interviews, the post-experience questionnaire was used for the latter reason. Specifically it provided a means to gather some helpful information that would have been a poor use of interview time, whilst also providing a modicum of understanding on how each student approached and perceived networked learning. As phenomenographic interviews should be semi-structured and response-led, covering general yet pertinent issues in the questionnaire allowed the interviews to be fully exploratory.

The educational and post-experience questionnaires were designed according to recognised conventions of good practice (Czaja & Blair, 1996; Oppenheim, 1992).

Questionnaire data was analysed using SPSS 10.0. Whilst the ASI has a specific analysis procedure that was followed, responses to the post-experience questionnaire were analysed to produce basic descriptive data only. Detailed statistical analysis is wholly inconsistent with naturalistic research, even if quantitative methods are used to provide supplementary data (Denzin & Lincoln, 1994b; Erlandson et al, 1993).

3.4.4 SEMI-STRUCTURED INTERVIEWS

The semi-structured interviews with individual participants were held post-experience, and conducted according to the general procedure for phenomenographic interviewing and analysis described in 3.1.4. Interviews were intended not to exceed one hour, and the average duration was around fifty minutes. All were audio recorded.

The interviews began with an explanation of their purpose, and reiteration of the confidentiality guarantee given at the start of the investigation. After asking the learner if they had any questions they would like to ask, the interview commenced. In keeping with phenomenographic procedure, the semi-structure prepared by the researcher comprised a list of general themes and issues and contained only one specific question. This was the opening question, in which the participant was prompted to begin the process of self-reflection by being asked to describe how they generally felt about having undertaken networked learning. The main topics covered thereafter depended to some extent on the features of the NLE used, and also the learning tasks and activities that provided the context for use. Common themes in all interviews included how the learner interacted with the environment, how they attempted to learn the subject content presented in the materials, how they felt different features of the environment helped them to learn, the ways in which networked learning differed from how they are used to studying on lecture-based courses, and whether they felt suited to networked learning.

Mindful of the potential criticisms of the phenomenographic method previously discussed, in conducting the interviews the investigator strove to ask questions in simple, jargon-free terms so as to aid comprehension and reflection on the part of the participant. In addition, leading questions that might influence the participant's response by indicating the opinion of the investigator were avoided throughout. Indeed, at the outset of the interview it was stressed that it was the opinion of the participant that was important, regardless of what that opinion was. When the investigator did prompt the participant, it was using phrases such as 'can you tell me a little more about…' or 'how do you feel about…'. Interviews were transcribed verbatim and analysed with the aid of the NUDIST application for qualitative data analysis, which proved to be a highly efficient means of both managing transcripts and carrying out the various stages of phenomenographic analysis. The researcher endeavoured to be led by the data rather than existing knowledge or preconceived notions, and ceased analysis only at the point when all comments had been accounted for and allocated to categories of description encompassing their core meaning: no comments were discarded because they did not fit categories already created. It is believed this rigour is reflected in a descriptive scheme that perhaps expectedly shares similarities with existing constructs of learning style or approach, but which would present to educational practitioners and researchers a recognisable account of the diverse ways students undertake networked learning.

The presentation and publication of both the developing findings and the theoretical framework produced by the research has suggested that the research has been largely successful in this respect (Smyth & Buckner, 2000; Smyth & Buckner, 2004).

3.4.5 PERIODIC KNOWLEDGE TESTS

These were the fortnightly tests administered as part of the experimental study to determine what had been learned in the preceding two-week block. The tests comprised three short-form questions to assess any conceptual knowledge gains, followed by a ten item multiple-choice component to assess any factual knowledge gains. The tests were designed in accordance with the higher education assessment guidelines of Brown et al (1997). A copy of one of the periodic knowledge tests is provided in Appendix VI.

While the multiple-choice component was assessed in the standard way, answers to the short-form questions were assessed according to the SOLO taxonomy of Biggs & Collis (1984). This enables the classification of learning outcomes against increasingly complex levels of conceptual understanding. The five categories of the SOLO taxonomy are prestructural, unistructural, multistructural, relational, and extended abstract. Respectively these represent no meaningful response, identification of one relevant issue, identification of several relevant issues, identifies and makes links between several or all relevant issues, and forms a hypothesis. Learning outcomes as measured by the SOLO taxonomy have been found to correlate closely with the approaches to studying classifications measured by the ASI, with only deep approach learners typically broaching the higher SOLO levels (Van Rossum & Schenk, 1984; Boulton-Lewis, 1998). This made the SOLO taxonomy an appropriate assessment tool to use, and one consistent with the main aspects of the methodological design.

3.5 SUPPLEMENTARY DATA COLLECTION AND ANALYSIS METHODS

The following describes additional data collection methods and their related analysis procedures. Unless otherwise indicated, these were used across all three studies.

3.5.1 USAGE LOGS

The usage log was essentially a self-completion log in which the participant was to record every on-line session. It contained a sheet for each week of the study, with each sheet including entries for multiple sessions. Designed to be as easy to complete as possible, all that was required was for the student to note the start and end time of each session, and then tick which areas and features of the environment were accessed. The purpose of the tool was to provide data relating to how often and for how long the NLE and parts thereof were utilised by the individual. However, logs and diaries of this kind are acknowledged as being unreliable, partly because students have to remember to complete them and partly because they can impede progress when learning via an educational application. For this reason such tools should only be employed if the desired data is unobtainable by other means (McAteer & Shaw, 1994). In this investigation the usage logs provided data that very basic web server logs could not. A standard spreadsheet application was used to analyse the data obtained through the logs.

Appendix VII contains a copy of the usage log distributed to the chemistry students.

3.5.2 ASSIGNMENT GRADES

Within case study one grades for individual pieces of work, and overall grades combining individual and group work marks, were used as to indicate how effectively a student was judged to have satisfied the formal learning objectives. In case study two the end of semester exam grades provided an equivalent measure of achievement.

3.5.3 ONLINE DISCUSSION CONTRIBUTIONS

To provide an additional insight into how individuals undertook networked learning, specifically how actively they utilised asynchronous communication features, a basic content analysis of online discussion contributions was conducted. As indicated in the literature review, various content analysis methods have been used to assess aspects of participation in and quality of online discussion (e.g. Henri, 1995; Newman et al, 1995; 1996). The sophistication of many such methods puts their effective use beyond the scope of this investigation. Therefore a simple classification scheme was developed to enable the qualitative nature of individual contributions to be efficiently determined.

The five main categories in the scheme were: opinion stated (OS); opinion stated and explained (OE); opinion referenced (OR); opinion referenced and elaborated (ORE); and document posted (DP). These were used to categorise messages in which: an opinion was given without explanation; an opinion was stated and explained; an explanation was justified with reference to the mediated course material or relevant online or print source; an explanation considered the implications of the referenced findings to the issue being discussed; and where a document URL, attachment or extract was posted without any explanation of pertinence to the task at hand or issue being discussed. Whilst intentionally simplistic, this scheme reflects the major potential uses of the conference facilities across the case and experimental studies, and as such can give a general account of how purposively or effectively an individual utilised them.

3.6 GENERAL ISSUES IN RELIABILITY AND VALIDITY

3.6.1 PILOTING

Within the field of social science research, conducting a pilot study prior to formal data collection is widely seen as best practice (Blaxter et al, 2001; Janesick, 1994; Maxwell, 1998). There are several reasons for this. Principally it gives the investigator an opportunity to evaluate the suitability and practicability of their research design, whether their methods are likely to provide sufficient data relating to the phenomena of interest, and to refine their ideas about the scope of the investigation. As such it is a safeguard to ensure the eventual findings have a methodologically sound basis, and an admission by the researcher that "you may think you know well enough what you are doing [but] things never work quite the way you envisage" (Blaxter et al, 2001, p. 136)

This investigation involved an extensive piloting phase during the first semester of the academic year 1998/1999. It was conducted at the institution of the researcher, and involved a full trial of the case study and naturalistic experiment. Both involved participants drawn from the same undergraduate course used for case study one and the formal experiment, but not the groups who would be approached to participate in the proper studies. The pilot case study had eighteen participants, and the experiment nine.

The data collection methods used were largely the same as those employed in the formal studies, although there were some differences. Instead of individual interviews, which were always going to be the main method for formal data collection, semi-structured focus groups were conducted instead. Focus groups are regarded as an effective means of facilitating in-depth, multi-faceted discussion on issues, as the group dynamic encourages participants to reflect on their own opinion in response to those of others, which can result in a wide range of comments and ideas (Morgan, 1997). It was therefore seen as an effective means of alerting the investigator to the range of perceptions and experiences that define the nature of autonomous networked learning from the student perspective, and thus place the investigator in a position to make informed decisions about the direction the investigation should take. The focus group had another purpose, and that was to generate content for the post-experience questionnaire. Rather than trying to second guess what issues the Likert statements in the final questionnaire should address, and how they should be worded, they were based on typical comments on recurring issues from the students involved in the pilot study focus groups. The pilot post-experience questionnaire was fairly short, and mainly administered to elicit feedback on layout and ease of completion.

Another difference between the pilot and formal studies was that the pilot involved field observation. This has been used within naturalistic research into student use of educational technology for identifying interesting aspects of interaction, perhaps on the part of a select few, that are not covered in data collection instruments or which the learner is unconscious of and may not report (Draper et al, 1996). However field observation was found to be of limited use, mainly because learners were interacting with NLEs at various times and from various locations. Setting up field observations was thus problematic, and in addition arguably imposed a false constraint upon how the learners interacted their environment: it was not uncommon for learners being observed during the pilot to ask if the researcher 'had seen enough', or to interact with the environment for an unusually long time without seeming to be doing much work.

During the pilot participants were encouraged to annotate anything that was not clear on the paper-based materials, including the experimental knowledge tests, and time was set aside at the end of each focus group to discuss what they liked and disliked about participating in the study itself. As a result a number of minor refinements to the data collection materials were made, including significant improvements to the layout the usage log. However, overall the participants believed the materials to be understandable, the format of the experimental knowledge tests appropriate, and the length of time required to participate in the research and each specific stage of data collection to be non-problematic and non-disruptive to their normal studies.

3.6.2 EPISTEMOLOGICAL COHERENCE OF SUBJECT AND METHOD

An important point concerning the general validity of a piece of research is whether the methodological approach is appropriate to the subject under investigation (Ely et al, 1991; Denzin & Lincoln, 1994; Blaxter et al, 2001). In naturalistic social science research this is often discussed in terms of internal validity, reflected in "the degree to which findings correctly map the phenomena in question" (Denzin & Lincoln, 1994, p. 100).

The main focus of this investigation is on understanding the different ways in which students approach networked learning, and the factors that influence the nature and outcomes of their interaction with NLEs. An NLE is essentially a form of constructivist learning environment. The central tenet of constructivist learning theory is that what the learner comes to understand, i.e. the knowledge they possess, they create for themselves as a result of their own unique experiences, perceptions and interpretations of the world. Constructivist learning theory, in common with the epistemological assumptions of naturalistic interpretative research, rejects the notion of an objective social reality and instead argues that there are multiple social realties based on the subjective ways in which individuals experience and interpret phenomena [4]. The principle research methodology of this investigation is phenomenography. This is a naturalistic method concerned with understanding the diverse ways in which students approach learning in higher educational contexts, and which relies on subjective descriptions of experience provided by students themselves in order to arrive at this understanding. The different ways that students approach learning, as understood through phenomenographic research, is said to reflect a unique form of constructivism (Entwistle et al, 1993).

It can therefore be confidently concluded that there is a high level of epistemological coherence between the methodological design, principle research method, and subject of this study. In this respect at least, the research can be considered generally valid.

3.6.3 TRIANGULATION OF DATA COLLECTION METHODS

Triangulation is a recognised strategy for enhancing the research validity of naturalistic research, essentially as it provides converging lines of evidence to support findings (Ely et al, 1991; Erlandson et al, 1993; Yin, 1994). Where mixed qualitative and quantitative methods are used, triangulation can be particularly valuable to "compensate for the fallibility of any single method or measure" (Bickman & Rog, 1998, p. xvii).

---

[4] Naturalistic research is also referred to as constructivist inquiry (Guba and Lincoln, 1994; Schwandt, 1994).

The primary method within this investigation was the phenomenographic interview. However, a range of additional methods were used to provide support for the phenomenographic findings, or to compensate where individual accounts from learners were an inappropriate means of obtaining the additional data required. In a supportive role, the post-experience questionnaire provided supplementary data that could be used to generalise about how students undertook and experienced networked learning, with the deeper insight into individual experiences facilitated through the interviews. In a compensatory role, assessment grades and knowledge tests provided a more accurate indication of learning outcomes than individual perceptions of learning effectiveness would, and the usage logs a more reliable account for patterns of interaction.

4.0 GENERAL INTERACTIONS AND PERCEPTIONS

This chapter relates to research objectives (i) and (ii), and presents the main findings from the post-experience questionnaire with illustrative comments from the interviews relating to general perceptions of the networked learning experience. The rationale is to determine whether at a broad level the multiple affordances associated with NLEs were actually experienced by the learners in this investigation, and to identify those extrinsic influences that may have had some impact upon whether or not they were realised. Consistent with the collective case study design this research employs, the findings from the case studies and experiment are presented together, although major or interesting differences between the various research contexts are acknowledged.

4.1 USE AND UNDERSTANDING OF NLEs

To provide a necessary insight into the conditions under which perceptions of the networked learning experience were formed, and against which they can be partially understood, the general patterns of student interaction with their NLEs, and the ways in which they were perceived as intended to support learning, should first be established.

4.1.1 PATTERNS OF INTERACTION WITH NLEs

As an indication of time invested in learning, the students were required to estimate their weekly average time spent reading the core course materials that were available within their environments. The emphasis on reading the material, rather than time spent studying online, was considered more appropriate given that the learners involved in the experiment and human factors module were able to print material for reading offline.

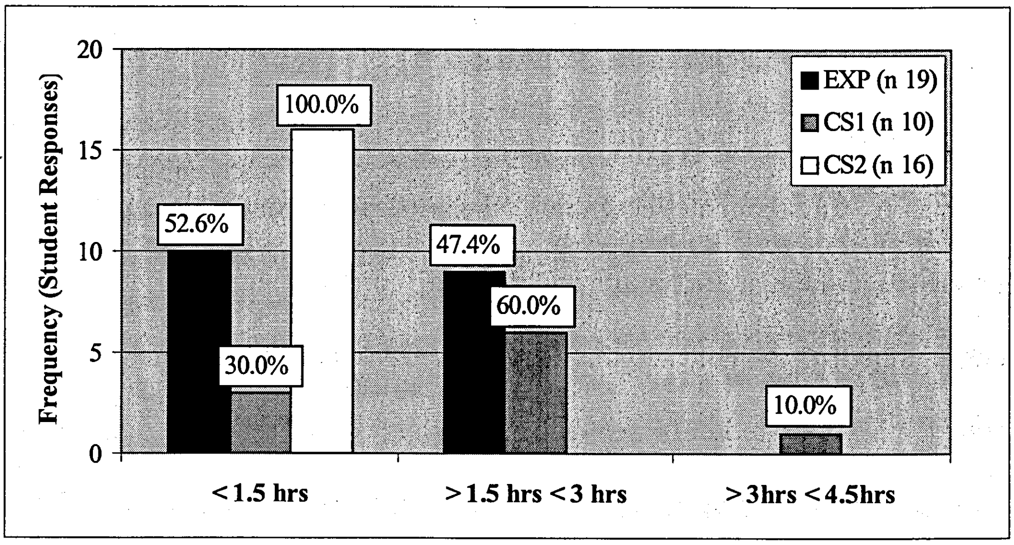


FIGURE 01: ESTIMATED WEEKLY AVERAGE TIME READING CORE MATERIAL

Overall, almost two thirds (n 29) of the students spent less than 1.5 hours a week reading the core materials, with one third (n 15) reading for between 1.5 and 3 hours. Only one individual reported reading for in excess of 3 hours. However as Figure 01 illustrates, there was considerable variation within and across the different research contexts. Students in the experiment were split almost evenly in reading for less than 1.5 hours and between 1.5 and 3 hours, whilst most of the human factors students indicated reading their core course materials for between 1.5 and 3 hours. Most notable is that none of the chemistry students spent more than 1.5 hours per week reading their material. Whilst this data provides only a general indication of time spent networked learning [1], it does suggest that the chemistry students used their environment the least overall. The fact that they were not formally required to undertake networked learning, despite being strongly encouraged to, should be acknowledged as a factor here.

Given the claims that are made for the educational benefits of self-paced, needs-based learning via networked environments generally, and hypertext specifically, an obvious

[1] A more detailed analysis of online patterns of interaction with the NLEs is presented in Chapter 6.0.

concern must be with the extent to which networked material was actually studied online. From Figure 2 it can be seen that across the experiment and human factors module, in which the option to print was readily available, only a fifth of the students (n 6) reported reading the material within their NLE exclusively online. Just over a third (n 11) had read the material online and also printed out copies to read offline, whilst a similar number (n 12) indicated that they only ever scanned the material online before printing it to read properly offline. One individual reported reading exclusively offline.

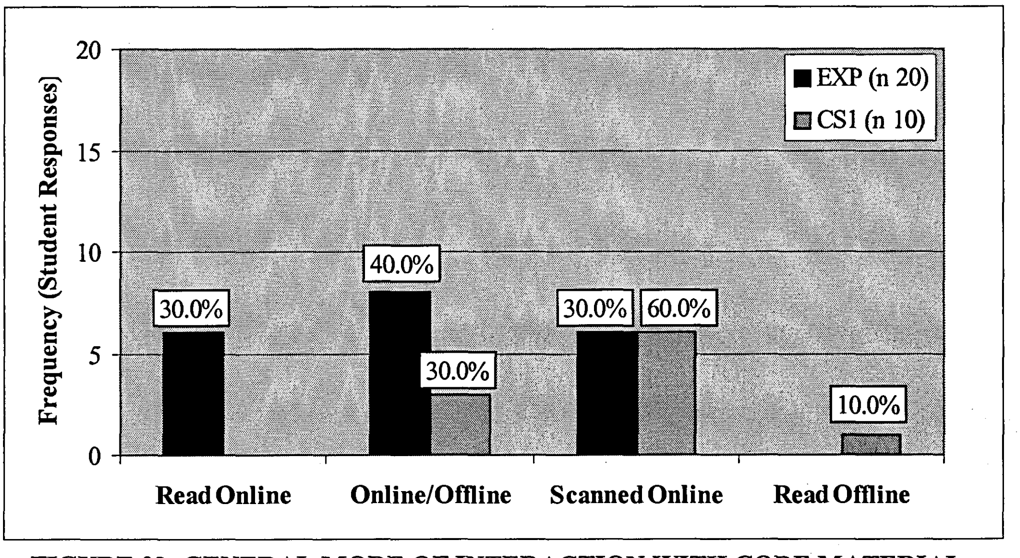


FIGURE 02: GENERAL MODE OF INTERACTION WITH CORE MATERIAL

It is interesting to note that all of those who read exclusively online were participating in the experiment, and that most of the human factors students only scanned their material online. It is also notable that as few students read exclusively on or offline, perhaps it cannot be assumed that these practices are always largely mutually exclusive, or that the majority always print to read offline, despite what previous studies have found (e.g. Crook, 1997b; Ward & Newlands, 1998). However, at this stage the salient point is that not all learning took place online - a factor that has implications for appreciating both the perceived experience of the students, and also the potential and actual effectiveness of their interactions with their networked environments.

Core materials aside, regarding how and how purposively the students interacted with the other main constituent elements featured within their environments, Tables 1 and 2 respectively relate to general patterns of interaction with supportive visual multimedia and asynchronous discussion facilities (e-mail was by and large rarely used) [2].

Supportive visual multimedia in the form of static, animated and interactive pictures and diagrams featured in two versions of the environment designed for the experiment, and was integral to the carbohydrate chemistry NLE where it took the form of interactive diagrams of chemical structures, and 3-D molecular models. Viewed broadly, it would seem that most of the students who were provided with supportive multimedia (n 25) utilised it fairly effectively. Approaching ninety percent (n 22) indicated always studying the images and diagrams when attempting to learn the topic being presented, with around seventy-five percent (n 19) studying any supportive multimedia that related to a topic they were having difficulty understanding. However, over a third (n 9) conceded that they often only looked at the supportive multimedia elements presented, as opposed to studying their content. Therefore, for some students at least, engagement with supportive multimedia was sometimes at a fairly superficial level.

Within each of the networked learning contexts, interaction with asynchronous discussion facilities was less active than it could have been. Although around a third (n 11) did seek further insight from their discussion facility whenever they had trouble understanding a topic, fifty percent (n 17) disagreed that they generally accessed it whenever they were online. Perhaps most tellingly, almost seventy-five percent (n 14)

[2] When frequency tables of post-experience questionnaire responses are presented, it is to summarise findings on issues common to two or more of the studies conducted. The Likert statements are abbreviated to reflect their core meaning, as equivalent statements were often worded slightly differently within the questionnaires to make contextual sense to participants in each case study, or in the different experimental groups. SA/A = Strongly Agree/Agree; U = Unsure; D/SD = Disagree/Strongly Disagree. EXP = Experimental Study; CS1 = Case Study 1 Human Factors in Information Management module; CS2 = Case Study 2 Carbohydrate Chemistry module.

of the human factors and relevant experimental study students stated that they only really used their discussion facilities to undertake the assessed collaborative activities.

TABLE 01: GENERAL INTERACTION WITH SUPPORTIVE VISUAL MULTIMEDIA

		N	SA/A	U	D/SD	Mean	St Dev
I always studied the graphical images/diagrams when attempting to learn the topic being presented...	EXP CS1 CS2	10 n/a 15	22 88.0%	1 4.0%	2 8.0%	3.88	0.73
I studied any graphical images/diagrams relating to a topic I had difficulty understanding...	EXP CS1 CS2	10 n/a 15	19 76.0%	2 8.0%	4 16.0%	3.80	0.96
I generally only looked at the graphical images/diagrams that struck me as visually interesting...	EXP CS1 CS2	10 n/a 15	4 16.0%	1 4.0%	20 80.0%	2.40	0.87
The graphical images/diagrams I looked at I only really referred to, as opposed to studying their content...	EXP CS1 CS2	10 n/a 15	9 36.0%	5 20.0%	11 44.0%	2.88	1.09

TABLE 02: GENERAL INTERACTION WITH ASYNCHRONOUS DISCUSSION FACILITIES

		N	SA/A	U	D/SD	Mean	St Dev
I generally accessed the discussion facility whenever I was online...	EXP CS1 CS2	9 10 15	14 41.2%	3 8.8%	17 50.0%	2.85	1.28
I accessed the discussion facility whenever I experienced trouble understanding a topic...	EXP CS1 CS2	9 10 15	11 32.4%	1 2.9%	22 64.7%	2.65	1.23
I only really accessed the discussion facility to undertake the (formally assessed learning activities)...	EXP CS1 CS2	9 10 n/a	14 73.7%	1 5.3%	4 21.1%	3.89	1.15

Of the fifty percent overall who did not tend to access their discussion facility whenever they were online, this included all but two of the carbohydrate chemistry students (n 13). This is unsurprising given the fact that none of the chemistry students, including those who opted not to participate in this research, actually contributed to it [3].

[3] Whilst sixteen students completed the chemistry case study, one student did not fully complete the post-experience questionnaire. Expect where indicated with 'CS2 (n 16)', there is always one non-response.

4.1.1 PERCEIVED ROLE OF NLEs IN SUPPORTING LEARNING

Phenomenographic research has shown that the way in which a student undertakes a specific learning task is partially informed by what they perceive to be required of them in that context (Marton & Saljo, 1976b; Entwistle, 1988). Although the principal factor in this respect is student understanding of formal learning objectives, this investigation tried to account for perceptions of how the NLEs and their main features were intended to support learning. The thinking was that what the students saw as the intended purpose of their environment may also have influenced how it was used, and was at the very least worth establishing if only to rule out any potential misunderstanding in this area as a factor that might have adversely influenced the networked learning experience.

As Table 03 illustrates, at a functional level the majority of the students seemed to share a clear understanding about the intended purposes of their respective environments.

TABLE 03: PERCEIVED GENERAL INTENDED PURPOSE OF NLEs

		N	SA/A	U	D/SD	Mean	St Dev
As a means for the distribution of the (module) course materials...	EXP CS1 CS2	20 10 16	36 78.3%	3 6.5%	7 15.2%	3.85	0.94
Providing the materials to be studied alongside channels for subject-related discussion...	EXP CS1 CS2	20 10 16	33 71.7%	9 19.6%	4 8.7%	3.74	0.85
To take advantage of the WWW as a resource for information retrieval...	EXP CS1 CS2	20 10 n/a	27 90.0%	0 0.0%	3 10.0%	4.20	0.89
An access point to relevant further reading located on the WWW...	EXP CS1 CS2	n/a 10 16	20 76.9%	0 0.0%	6 20.0%	3.54	0.99

The post-experience questionnaire responses on the perceived purpose of the supportive visual multimedia are summarised in Table 4. Approaching ninety percent of all those presented with supportive multimedia (n 26) felt the images and diagrams were intended to be an integral part of the subject material within the environment.

TABLE 04: PERCEIVED INTENDED PURPOSE OF SUPPORTIVE MULTIMEDIA

		N	SA/A	U	D/SD	Mean	St Dev
I feel the graphical images/diagrams were intended to be an integral part of the material we studied...	EXP CS1 CS2	10 n/a 16	23 88.5%	2 7.7%	1 3.8%	4.00	0.63
Graphical images/diagrams were generally only to be studied if the topic presented proved difficult...	EXP CS1 CS2	10 n/a 15	10 40.0%	1 4.0%	14 56.0%	2.80	1.15
I feel the graphical images/diagrams were mainly intended to make the (NLE) interesting to use...	EXP CS1 CS2	10 n/a 15	14 56.0%	3 12.0%	8 32.0%	3.40	1.22

Over fifty percent (n 14) also disagreed that the multimedia elements were only there to be studied when experiencing difficulty in understanding a topic, although somewhat less positively the same number of students felt the images and diagrams were mainly intended to make the environment interesting to use. Although speculative, perhaps some of those who held this view were also likely to be included in the number who indicated that they looked at rather than intentionally studied the supportive multimedia.

TABLE 05: PERCEIVED INTENDED PURPOSE OF ASYNCH. DISCUSSION FACILITIES

		N	SA/A	U	D/SD	Mean	St Dev
The discussion facility was primarily to be used for doing the (formally assessed learning activities)...	EXP CS1 CS2	9 10 n/a	16 84.2%	1 5.3%	2 10.5%	4.05	0.91
The discussion facility was partly intended to be an open platform for general subject-related debate...	EXP CS1 CS2	9 10 15	24 70.6%	7 20.6%	3 8.8%	3.68	0.94
I saw the discussion facility as a channel for raising questions on topics I had trouble understanding...	EXP CS1 CS2	9 10 15	11 32.4%	8 23.5%	15 44.1%	2.74	1.16

In relation to asynchronous discussion, over eighty percent (n 16) felt that the facilities provided for this were primarily to be used for the formally assessed collaborative activities, which is consistent with the similar number who indicated that they only used them for this purpose. Although a majority conceded that the discussion facilities were also supposed to be used for general subject-related debate, half of the students on the human factors module were either unsure or disagreed, with a couple of individuals within each of the other research contexts also unclear on this issue. On a personal basis very few students saw their discussion facility as a place where they could initiate a collaborative exchange. Although this seems contradictory alongside the majority who believed there was a wider purpose to the discussion facilities, the interviews revealed that a number of factors had discouraged student-initiated participation.

4.2 PERCEPTIONS OF THE NETWORKED LEARNING EXPERIENCE

Although the preceding data provides limited insight into the ways individual students interacted with their NLEs, it does usefully confirm a degree of variation amongst how much time was invested in networked learning, how much of this actually occurred online, and how students generally perceived and interacted with their environments.

Across the three research contexts, the chemistry students utilised their environment the least overall, but it is apparent most students felt they understood how they were to use their NLEs, and interacted at some level with the range of resources at their disposal.

4.2.1 NLEs AND LEARNING

Leaving aside for now the affordances associated with the constituent features of a NLE, their integration within a web-based environment is thought to offer specific educational advantages by itself. The spatial-temporal consolidation of resources has the potential to maximise the continuity of, and time spent, studying through facilitating "one stop shopping" learning (Hill, 2000). Related to this is the fact that learning can be undertaken at any time, therefore allowing the individual to learn when it is most convenient and conducive to their own knowledge development (Berge et al, 2000; Romiszowski, 1997a). There is also the opportunity for learning to be extended beyond the immediate environment through access to relevant further material on the web, or by the students themselves searching the web to locate knowledge-enhancing information.

The majority of the students appreciated having instant, single-point access to the range of resources they were likely to require (Table 06). Ninety percent (n 40) valued this aspect, and all of those required to use discussion facilities recognised that when working online contributions to a discussion can be made as soon as the idea for one occurs. Although e-mail was infrequently used overall, almost everyone had valued this being available for seeking tutor assistance if and when necessary. The interviews revealed that simply knowing this option was there if need be was reassuring.

TABLE 06: PERCEIVED VALUE OF INTEGRATED ENVIRONMENT - GENERAL ISSUES

	N		SA/A	U	D/SD	Mean	St Dev
When working online I valued the instant access to whichever materials or features I required...	EXP CS1 CS2	20 10 16	40 89.9%	0 0.0%	6 13.3%	4.02	0.91
When working online contributions to the discussion facility can be made as soon as the idea occurs...	EXP CS1 CS2	9 10 n/a	19 100.0%	0 0.0%	0 0.0%	4.27	0.45
Immediate access to e-mail for contacting the tutor is valuable when working online...	EXP CS1 CS2	20 10 15	39 86.7%	2 4.4%	4 8.9%	4.04	0.90
The availability of further reading material via the WWW links was a valuable feature of the (NLE)...	EXP CS1 CS2	n/a 10 15	10 40.0%	9 36.0%	6 24.0%	3.16	0.80

The following comment typifies the benefits seen in single point access to resources:

"It was all in the same place, so you didn't feel like you had to do this, then you had to do that. It was kind of 'this is the lecture notes', and then you can discuss it, look more up on the web, and if you didn't understand it you can just e-mail. It was easier than having to jump about...You can think 'wait a minute, that doesn't make sense', go back, and read something else...or click and go straight to the glossary. You don't have to go find a dictionary, or find somebody else to ask."

The opportunity to study autonomously via NLEs, and the benefits often associated with doing so, are at a detailed level of consideration inseparable from the educational properties of hypertext. However, at a broad level the majority were also found to have largely appreciated what their environments offered in terms of studying at times conducive to learning. As Table 07 shows, eighty percent (n 36) agreed that they were able to access the course materials and undertake learning as and when was convenient.

TABLE 07: PERCEIVED VALUE OF INTEGRATED ENVIRONMENT - STUDYING ISSUES

	N		SA/A	U	D/SD	Mean	St Dev
The (NLE) enabled me to access materials and undertake learning as and when convenient...	EXP CS1 CS2	20 10 15	36 80.0%	1 2.2%	8 17.8%	3.89	1.07
Not being in university does not mean missing out on content...	EXP CS1 CS2	20 10 15	29 64.4%	6 13.3%	10 22.2%	3.51	1.14
Learning was very organised as all the materials were available in advance in one environment...	EXP CS1 CS2	20 10 15	33 73.3%	4 8.9%	8 17.8%	3.80	0.81

The consensus was that by studying at a time that suits the individual, for example when they are feeling most motivated to do so, more effective learning is likely to occur:

"The thing I really liked about the web site was being able to go on it whenever I had time to, because sometimes you wake up on a Monday morning you're thinking 'No, I think I'll miss this lecture'...So you don't always go to everything, whereas with the web-based learning you can just to do it whenever you've got time... I find [sic] I took more in because I'd actually go 'Right, I'm going to go on this and I'll have a look at that' or whatever, and I was wanting to be there."

For some individuals an important benefit associated with the availability of networked course material was that 'not being in university does not mean missing out on content' (n 29). However the issue was a contentious one. Those without off-campus access, or who felt they had poor on-campus access, expressed in the interviews the belief that their opportunity to learn anytime, anyplace was actually fairly limited.

Also limited in their ability to fully benefit from the opportunity to learn when they wanted to were those individuals who simply did not feel self-motivated, or otherwise well-equipped enough, to assume this responsibility for their own learning. As one student explained: "I'm better off having a structure handed to me, of 'Be there by this time'...It comes down to time management and having to juggle things. It's easy to say 'Well, I've got next week to do that' so it goes to the bottom of the list". What these more negative findings in relation to self-paced studying suggest is that regardless of there being a positive consensus view on a particular aspect of networked learning, other factors may well impact how tangible for some the potential benefits actually are.

Overall, almost three-quarters (n 33) felt the provision of all the core materials from the outset contributed towards their learning being organised, although there was less certainty over the value of the external web links to further readings that the human factors and chemistry students had access to. Just forty percent (n 10) agreed these were a valuable feature of their environment, and during the interviews it became apparent that many students had not used the external links provided, either because they had relied solely on the core materials from the start, or because they felt they provided more information than was necessary for the studying or assignment being undertaken.

On the issue of using the web to source information for themselves, ninety percent of the human factors students (n 9) had 'found the web a valuable resource for locating additional course-related material and references'. During the interviews all the human factors students described using the web in this capacity on at least a few occasions, and although for most this was mainly in relation to completing their collaborative assignment, some individuals used it for more than this expected purpose. A few also explained that the process of conducting a search was cognitively beneficial in itself, requiring them to consider what they already knew against what they needed to find out.

4.2.2 HYPERTEXT AND LEARNING

Hypertext material is seen as conducive to effective, need-based learning as the learner is able to focus on the topics and issues that are most relevant to their requirements. Thought to be associated with this process is more active and reflective construction of knowledge on the part of the learner, who is forced to interpret information and make their own choices about which paths of enquiry to pursue (Jonassen, 1989, 1992).

In being required to interact autonomously with their respective NLEs, the students in this investigation had no option but to determine for themselves the pace and manner in which they progressed through the hypertext-based course material. What is of interest is how in doing so they felt their learning was supported, and whether it was supported in any ways that are consistent with the main affordances described in the literature.

TABLE 08: PERCEIVED VALUE OF HYPERTEXT-BASED MATERIAL 1 - SELF-PACING

		N	SA/A	U	D/SD	Mean	St Dev
Studying with the (NLE) let me control the pace at which I learned the (mediated subject material)...	EXP CS1 CS2	20 10 15	40 88.9%	0 0.0%	5 11.1%	4.02	0.84
As the (mediated subject material) came complete, you do not miss points as can happen in lectures...	EXP CS1 CS2	20 10 15	36 80.0%	1 2.2%	8 17.8%	3.89	1.07
Having all the (mediated material) available at once helped me form a good overview of the subject area...	EXP CS1 CS2	20 10 15	35 77.8%	6 13.3%	4 8.9%	3.87	0.89

Table 08 shows the responses to the relevant post-experience questionnaire items on the opportunity for self-paced learning via networked hypertext material, and a fairly convincing consensus on the key and related issues. Almost ninety percent (n 40) of all the students agreed that they were able to control the pace at which they learned the subject material. Many summed up what they perceived to be the main benefits of self-paced learning in similar terms, often contrasting it with lecture-based courses:

> "If it was something that you didn't understand you can concentrate more time on it, whereas in lectures you've only got an hour and that's it really...On the web-based learning you can go 'Oh, I know that' and just leave it...It's almost more responsive to what your needs are and what you need to understand about."

In addition, around eighty percent (n 36, n 35) believed that the completeness of the material lessened the danger there is in lectures of missing important points, and that having all the material available at once helped them to form a good overview of the subject area. A number saw this as advantageous because, rather than with subject material being delivered piecemeal, they "knew what the whole thing was going to entail rather than suddenly going into something completely new that you maybe weren't sure about. If you can see it's there you're going get used to it, knowing what you have to do from the start". It therefore seems that access to networked course material may have usefully provided at least some of the students with the opportunity to more fully orientate themselves towards the learning that was to be undertaken.

Together with the post-experience survey findings, the above comments, and those like them, confirm that regardless of how successfully individual learners might yet be found to have exploited the opportunity for self-paced progress through their hypertext course materials, the majority believed this was an important benefit of autonomous networked learning. Interestingly, while for a number of students the value of self-paced, needs-based progress through the mediated material was associated with reading it in hypertext-form online [4], this held equally true for those who indicated that they were printing the material to read it partially or exclusively offline. So online or offline, clearly the opportunity for self-paced (as opposed to lecturer-paced) learning still exists.

As many of the students felt they benefited from the opportunity for self-paced progress through their networked course material, a pertinent question is whether in practice this was associated with the more active, reflective approach to knowledge appropriation that constructivism associates with hypertext? As Table 09 illustrates, for some it was.

[4] As will be established in Chapter 6.

TABLE 09: PERCEIVED VALUE HYPERTEXT-BASED MATERIAL 2 - ACTIVE LEARNING

	N		SA/A	U	D/SD	Mean	St Dev
I felt more personal responsibility for my own learning than I would in a lecture-based course...	EXP CS1 CS2	20 10 16	37 80.4%	1 2.2%	8 17.4%	3.65	1.28
Studying independently encouraged me to think very carefully about the topics being learned...	EXP CS1 CS2	20 10 16	36 78.3%	1 2.2%	9 19.6%	3.69	0.92
I feel web-based learning generally requires more mental effort on the part of the learner...	EXP CS1 CS2	20 10 16	30 65.2%	4 8.7%	11 23.9%	3.64	1.09

Eighty percent (n 37) indicated that they felt more personally responsible for their own learning than they would in a lecture-based course. If this points towards an increased awareness or sense of involvement in the learning process, then it is certainly consistent with the comparable number (n 36) who believed that studying largely independently encouraged them to think carefully about the topics they were learning. While a few disagreed, approximately two-thirds (n 30) also thought networked learning required more mental effort on their part. These general perceptions were corroborated through the interviews, and for some students the self-paced, independent nature of networked learning certainly had demanded more active engagement with their course material:

> "You have to be switched on. I do think that you actually have to put more effort into. A lecture, it seems to be more or less spoon-fed and it's the opinion of the lecturer...whereas if you're trying to learn something off the web-base then you actually have to concentrate...I would say you get more benefit out of that because I would be trying to understand it myself. You have to react."

On the whole then, most of the learners felt they benefited from studying with their hypertext-based course material, or were required to study it, in ways that are largely consistent with the idea that hypertext material can facilitate active, self-paced learning.

At least to the extent that they were perceived, it could be said that these potential affordances were realised within the networked learning contexts investigated.

4.2.3 MULTIMEDIA AND LEARNING

Supportive visual multimedia was a prominent feature of both the carbohydrate chemistry site, and two versions of the 'colour in computer graphics' environment developed for the experiment. As the findings in 4.1.1 indicate, most of the students did interact to some extent with the supportive multimedia that featured in these NLEs.

Constructivist learning theory, and contemporary cognitive theory, suggests supportive multimedia can aid the appropriation and application of knowledge by: facilitating knowledge transfer through studying authentic visual representations; enabling the dual coding of complementary visual and textual information; and by facilitating cognitive offloading. Little substantial qualitative-based research into the educational potential of supportive multimedia seems to have been conducted, with much of what we currently understand originating from speculative theory and controlled cognitive experiments. However, although it was clear from the outset that this part of the research would be fairly exploratory in this respect, there was evidence in the responses and descriptions of some students that benefits in these three areas had been experienced.

The constructivist notion of authenticity in relation to multimedia and knowledge transfer is based on the premise that the nature and potential value of knowledge is influenced by the conditions prevalent when it was developed. If information is presented in a form that matches or more closely resembles the form in which it is found outside the instructional environment, rather than presented abstractly, then the learner should more readily be able to apply it in new contexts (CTGV, 1993a, 1993b; Honebein et al, 1993). Within the experiment, the various images and graphics that some students were exposed to provided complimentary visual representations of the same objects, phenomena or processes that were being explained within the text.

TABLE 10: PERCEIVED VALUE OF SUPPORTIVE VISUAL MULTIMEDIA - EXPERIMENT

		SA/A	U	D/SD	Mean	St Dev
The graphical images were a valuable aid to understanding the textual content of the theory base...	EXP (n 10)	9 90.0%	0 0.0%	1 10.0%	4.50	0.97
Recalling the graphical images helps me to remember the topics covered in the theory base...	EXP (n 10)	9 90.0%	1 10.0%	0 0.0%	4.60	0.70
The graphical images helped me to see how the theoretical issues related to the real world...	EXP (n 10)	10 100.0%	0 0.0%	0 0.0%	4.60	0.52
The written tests would have been harder had I not seen the graphical images in the theory base...	EXP (n 10)	8 80.0%	2 20.0%	0 0.0%	4.50	0.85

As indicated in Table 10, all of the relevant experimental students (n 10) felt that the supportive images helped them to see how the theoretical issues they were reading about related to the 'real world'. This may represent a form of 'local' knowledge transfer in which the student was able to make the leap from simply comprehending the abstract descriptions in the text to more fully understanding how the objects or processes being explained are actually instantiated. For many the images also seemed to facilitate the application of knowledge out with the environment, as eighty percent (n 8) agreed that the periodic written tests, in which questions on the topics studied were asked in relation to previously unseen images, would have been more difficult had they not already seen the examples in the material. As one student explained how both the 'local' and external transfer of knowledge was aided by the supportive images:

> "It makes it easier to apply. Like instead of just text, text, text when you read academic texts and it's difficult to understand because there's no real world connotation to it, there's just theory…the images helped me understand the different contexts for the concept or the fact I was learning...In the tests there was images that were similar to the illustrations, and it all came back. The images were easy to relate to because you'd already seen examples of the same thing."

The knowledge transfer enabled by the authentic visual representations those participating in the experiment studied was also found to have helped when undertaking the practical activities they were set, giving them a clear understanding of what they were looking for when identifying their own examples of colour use that typified aspects of the theory studied. For the chemistry students the main opportunity for transferring knowledge gained from the supportive multimedia within their environment was the end of semester exam. There was some evidence of this having occurred, and two or three individuals explained that in answering questions that involved completing 2-D molecule diagrams, having studied them in their 3-D online form helped as "when you have got the 2-D on paper and you've got to put the 3-D bonds in, if you've already got the 3-D in your head then it's easier to understand where you're going to put them."

In relation to possible dual-coding benefits, the basic theoretical proposition is that complementary visual and verbal information, containing equivalent information and presented concurrently, has an additive processing effect which allows information to be learned and recalled more easily as visual and verbal information are encoded to and retrievable from their own memory channels (e.g. Paivio, 1986; Clark & Paivio, 1996)

If any enhanced cognition effects associated with supportive multimedia were going to be experienced, it was likely to be within the experiment where the visual multimedia was presented alongside text with comparable informational content. As the other responses in Table 10 show, ninety percent (n 9) of the relevant students agreed that the supportive images effectively aided their understanding of the text in their subject material. More importantly, the same number believed that by recalling the images this helped them to remember the related content within the material. This suggestion of possible dual-coding effects was further elaborated through the interviews:

> "It helped it stay in my mind better than if it had just been just words. When I remembered a graphic then I'd remember the idea behind it, and why it was there...In some of [the periodic knowledge tests] I remembered seeing the pictures and that made me remember why the picture was there in the first place and I remembered the words behind it. So it jolted my memory into working."

Some students were even able to give specific examples:

> "There was one [graphical image] which was of the London Underground map that had helped me to understand nominal coding, because I was in the exam, well the test, and I just couldn't remember what it was. Then I remembered that map, so it helped me to explain what nominal coding was. Remembering the picture helped me remember the idea. It did with that one anyway."

On the general issue of visual multimedia, learning and recall, around eighty-five percent (n 13) of the chemistry students indicated that their interactive diagrams were an effective way to learn about the reactions depicted (Table 11). Most also agreed (n 10) that they contributed significantly to their understanding of the structures or reactions depicted, whilst forty percent (n 6) further believed that recalling the interactive diagrams helped them to remember details of what had been depicted.

TABLE 11: PERCEIVED VALUE OF INTERACTIVE DIAGRAMS – CASE STUDY 2

		SA/A	U	D/SD	Mean	St Dev
The interactive diagrams were an effective way to learn about the chemical reactions depicted…	CS2 (n 15)	13 86.7%	0 0.0%	2 13.3%	3.73	0.70
Interactive diagrams contributed significantly to my understanding of the reactions depicted…	CS2 (n 15)	10 66.7%	3 20.0%	2 13.3%	3.60	0.83
The interactive diagrams made learning about chemical reactions easier than static diagrams do…	CS2 (n 15)	12 75.1%	0 0.0%	4 24.9%	3.62	1.20
Recalling the diagrams helps me remember details of the structures or reactions depicted…	CS2 (n 15)	6 40.0%	1 6.7%	8 53.3%	2.87	0.99

Cognitive offloading, the third way in which supportive visual multimedia is thought to aid learning, manifests itself in "the extent to which different external representations reduce the amount of cognitive effort to solve informationally equivalent problems" (Scaife & Rogers, 1996, p. 188). For constructivists the phenomena is central to the concept of distributed cognition, whereby the learning of an individual is optimised by the tools or artefacts within their environment that essentially make them "smarter", or more cognitively able, when they are using them (Salomon, 1993; Bell & Winn, 2000).

Evidence for cognitive offloading was forthcoming in both the experiment and the chemistry case study, but particularly in relation to the 3-D Chime models that featured in the chemistry environment. Table 12 summaries the questionnaire responses provided by the chemistry students in relation to the value of the Chime models.

TABLE 12: PERCEIVED VALUE OF CHIME MODELS – CASE STUDY 2

		SA/A	U	D/SD	Mean	St Dev
The Chime models were an effective means of learning about the chemical structures depicted...	CS2 (n 15)	10 66.7%	3 20.0%	2 13.4%	3.47	0.92
The Chime models contributed significantly to my understanding of the structures depicted...	CS2 (n 15)	5 33.3%	4 26.7%	6 40.0%	2.93	0.88
The Chime models made learning about structures easier than text with diagrams alone would...	CS2 (n 15)	9 60.0%	3 20.0%	3 20.0%	3.40	1.06
Recalling the Chime models helps me to remember details of the chemical structures depicted...	CS2 (n 15)	4 26.7%	5 33.3%	6 40.0%	2.87	0.83

The main purpose of the Chime models was to present chemical structures in a rotatable 3-D format in a similar way to plastic ball-and-stick models. They could also be edited to change aspects of their presentation. Two thirds (n 10) of the chemistry students believed the Chime models were effective for learning about the structures depicted. Most (n 9) also felt they were more effective for doing so than text and static diagrams [5]. Whilst there was an approximate split between those that thought they aided their understanding significantly (n 5), were unsure (n 4), or who disagreed (n 6), for the students who did feel they benefited from the Chime models the main advantage was in forming a mental representation or appreciation of the molecule presented, and doing so more efficiently than they could have had it been depicted in a normal textbook format:

> "They were really good. It gives you an idea of how things are sitting. And when you see something in 2-D on a page it's quite hard to visualise it in 3-D, like the stereochemistry of molecules and things like that. So it's good to be able to rotate them and to have a wee look. It helps you visualise things...I've tried to do it in

[5] Interestingly, the sixty percent or so from the chemistry module who felt the Chime models were effective, and more so than text and diagrams, is consistent with the number of chemistry students who were found to hold similar views of their 3-D models in the study by Hyde et al (1996).

my head without models and I tried to rotate things round but it helps if it's on the screen. You're not sat there for ages trying to think 'What way is it going?'."

Similar comments relating to the cognitive offloading value of the interactive diagrams were also made, typically along the lines that their expandable sections allowed a faster, better appreciation of what was being depicted, especially in comparison with equivalent static diagrams that may span more than one page in a textbook. However, for some individuals there were no cognitive offloading benefits to be gained:

"I actually get more confused when you've got 3-D pictures. We've got chemical models, balls with sticks you can put together, and I don't use them because they confuse me more...If I had a problem visualising something it might have helped, like if I suddenly had problems, but I find it quite easy to visualise molecules."

In a similar way to the student who disliked the opportunity for self-paced learning because of the self-dependence this required, what this example further suggests is that while it is possible the potential benefits of networked learning may be experienced by many, the characteristics of individual students can have a delimiting influence.

4.2.4 ASYNCHRONOUS COMMUNICATION AND LEARNING

The principal affordance claimed for asynchronous online communication is that because students can take longer to reflect on the opinions of their peers and tutors, and formulate and express their own, this could result in a greater depth of discussion and subsequent personal understanding than might be possible in a face-to-face or other synchronous exchange (Kaye, 1992; Henri, 1995). A second potential benefit associated with asynchronous communication is that it may, for some students, present a more egalitarian platform for discussion in that those normally inhibited, reserved, or otherwise marginalized in face-to-face seminar situations are more likely to contribute.

Asynchronous discussion facilities featured within the human factors NLE, and two versions of the environment developed for the experiment. The majority of the relevant students felt they benefited to some extent from the reflective nature of their asynchronous discussions (Table 13). Approaching one hundred percent (n 18) agreed that using their discussion facility gave them time to consider their own thoughts carefully before contributing, and around three quarters (n 14) also felt that they had time to reflect fully upon the views of others. Most commented positively on these opportunities, and some had acted upon them: "I read the Conference Space, printed out what people had written...went away to the library, and then I sent a suggestion back maybe two days later after I'd done a bit of research on what had been said".

Around eighty percent (n 15) further believed that reading the contributions of their peers helped them understand issues from new perspectives. This may have been a marginal benefit, as only forty percent or so (n 8) felt able to state that using the discussion facilities contributed to their understanding of the subject area they were studying. In addition, only a third (n 7) felt they generally expressed themselves more clearly than they would have in a traditional seminar situation, and only a quarter (n 5) believed the facilities enabled a better quality of discussion than is possible face-to-face.

It therefore seems that for many of the students in this investigation, asynchronous communication was not as beneficial as it is often claimed it can be. However, eight of the eleven students who disagreed that the quality of the online discussions was better than classroom debate were from the human factors module, and in the human factors module the almost wholly negative perception is likely due to the nature of the task they were required to undertake online (as the findings in 4.2.5 make evident).

TABLE 13: PERCEIVED VALUE OF ASYNCHRONOUS DISCUSSION FACILITIES

		N	SA/A	U	D/SD	Mean	St Dev
Using the discussion facility gave me time to consider my thoughts carefully before contributing...	EXP CS1 CS2	9 10 n/a	18 94.7%	1 5.3%	0 0.0%	4.32	0.58
Using the discussion facility gave me time to reflect fully upon issues raised by fellow contributors...	EXP CS1 CS2	9 10 n/a	14 73.7%	2 10.5%	3 15.8%	3.79	1.13
Reading discussion facility contributions helped me understand issues from new perspectives...	EXP CS1 CS2	9 10 n/a	15 78.9%	1 5.3%	3 15.8%	3.84	0.96
Using the discussion facility contributed to my understanding of the (subject being studied)...	EXP CS1 CS2	9 10 n/a	8 42.1%	5 26.3%	6 31.6%	3.16	1.26
The discussion facility enabled a better quality of discussion than is possible in a classroom debate...	EXP CS1 CS2	9 10 n/a	5 26.3%	3 15.8%	11 57.9%	2.58	1.17
I generally expressed myself more clearly in the discussion facility than I would in a classroom debate...	EXP CS1 CS2	9 10 n/a	7 36.8%	3 15.8%	9 47.4%	2.84	1.17

Although most saw the ability to reflect on the contributions of oneself and others as a positive attribute of asynchronous discussion, a number nevertheless had a personal preference for face-to-face interaction that might help explain the more negative perceptions. Again suggestive of the influence individual characteristics might have upon how effectively NLEs can support specific aspects of learning for some, as one student explained: "I really enjoy [face-to-face] discussions because I can be a bit crazy, throw up points. Just sort of verbally sparring with people. You can't really do that in a discussion group...and I found that limited my creative flow or output sometimes".

On the issue of equality in participation, almost eighty percent (n 15) disagreed that 'the idea of your contributions being constantly available online was intimidating'. This may be seen as a general indication that most of the students experienced no inhibition in actually participating in online discussion, yet is was also apparent that the lack of visibility in asynchronous communication helped to ensure the involvement of certain individuals: "I found it easier because I could write down what I thought...I think it's because I'm quite quiet and shy and withdrawn a wee bit, myself. So I felt it easier just writing things down...It is less intimidating online than it would be face-to-face." For the small number who shared these feelings, it was therefore clear that the more egalitarian nature of asynchronous discussion was of definite value.

4.2.5 INSTRUCTIONAL FACTORS INFLUENCING NETWORKED LEARNING

Although many students felt they benefited from interacting with their NLEs in ways consistent with the affordances described in the literature, the environments were not always utilised, or perceived to have supported learning, as effectively as they might have been. A number of instructional factors emerged as important in this respect.

Broad opinions on the general quality of the networked course material are illustrated in Table 14. Regarding the quality of their subject-related materials, over eighty percent of all the students (n 39) thought these had provided understandable explanations of the topics that were presented. The general feeling was that there was nothing in the respective subject materials that was too difficult to grasp for a student working alone via their NLE, which meant that the students could attempt to appropriate knowledge in a focused, uninterrupted manner. Many students saw this as critically important to effective networked learning, explaining that whilst in lecture situations instant clarification on issues could be sought, "with the online study notes you've only got what's there...You'd need to have constant contact with your tutor if you don't understand what's there, or then use other information sources to back up what's there, so I think it's very important that what they give you is relevant and easy to understand."

On the few occasions students had encountered problems with the quality of their subject material, it was to do with the breadth or depth, rather than clarity, of coverage. For example, a few of the human factors students felt the notes on the topic of cognitive ergonomics could have provided further explanation at a basic level, with that offered perceived as minimal given the importance of understanding this topic to the assessments being undertaken. This resulted in a level of uncertainty about this topic that led some to consulting either the tutor or sourcing further material for clarification.

In addition to subject material, the environments for the experimental study and human factors module included areas for 'administrative' material comprising a weekly breakdown covering the topics to be studied, describing the tasks or assignments to be completed and their deadlines, and in the experimental study providing times and locations for the periodic knowledge tests. Again over eighty percent (n 26) agreed that their respective administrative materials had, at a general level, provided a clear breakdown of the work to be undertaken each week. The consensus was that although good information of this kind is always vital, it is of increased importance in networked learning where the student has to be more self-managing: "When you're responsible for it there's more of an onus on you to know when you've got to do things. When you're doing it with a lecturer usually the lecturer will tell you. So it's good if when you're doing something on your own there is some back-up that you can go and look at if you're confused, because you can't always go to a lecturer."

The need for good administrative information to help foster the conditions for effective networked learning to occur was attested to by the instances in which a poor quality of information was felt to have limited progress. Although three-quarters (n 23) of the experimental and human factors students overall indicated that their task or assignment specifications had clearly explained what was to be undertaken, less than half of the human factors students (n 4) actually agreed with this. Little of this uncertainty was associated with the asynchronous discussion-based group problem solving assignment, but the specifications for the other three assignments were felt not to have provided enough guidance in terms of possible approach and final content. This led to consultations with the tutor, via e-mail and in person, to clarify the purpose of the assignments and to determine what key resources within, and outwith, the NLE should be drawn upon. The perceived poor quality of this information therefore resulted in some students having an inadequate sense of the direction they should take with certain assignments, which until resolved somewhat limited their progress in completing them.

TABLE 14: PERCEIVED GENERAL QUALITY OF ONLINE COURSE MATERIALS

	N		SA/A	U	D/SD	Mean	St Dev
The (subject material) provided understandable explanations of the topics presented...	EXP CS1 CS2	20 10 16	39 84.8%	3 6.5%	4 8.7%	3.89	0.74
The (administrative material) provided a clear breakdown of the work to be undertaken each week...	EXP CS1 CS2	20 10 n/a	26 86.7%	2 6.7%	2 6.7%	4.20	0.85
The (task or assignment specifications) clearly explained what the (tasks or assignments) to be undertaken involved ...	EXP CS1 CS2	20 10 n/a	23 76.7%	4 13.3%	3 10.0%	3.97	1.03
I feel the (NLE) generally contained enough information to guide me in using the resource...	EXP CS1 CS2	20 10 16	36 78.3%	2 4.3%	8 17.4%	3.78	0.94

The respective environments in all three studies contained varying levels of information about how they were to be used. The consensus was that this information was at least adequate, with eighty percent of all the students (n 36) indicating that their NLE generally contained enough information to guide them in using it. Most of those who did not hold this view were chemistry students, and for this cohort the implications of not having clear guidance on how to utilise their NLE were particularly serious.

Most problematic was the lack of explicit information the chemistry students were provided with about the general purpose of their environment, and how it was to support learning in relation to the lecture component of their module. The NLE provided more subject coverage, examples, self-test activities and scope for discussion amongst students and the tutor than the lecture-based part of the module could, and for this reason it was intended to be the main focus of studying activity on the module. Yet no information regarding the role or importance of the environment was provided online, and the interviews revealed that the only formally communicated information about this was delivered verbally during the introductory workshop at the start of the semester.

Perhaps due to it being delivered only verbally, few of the chemistry students felt they could recall or had an understanding of the guidance that had been offered. This was evident from comments like "I didn't know what we were supposed to take out of the website", "I thought it was just like a back up, like a thing to go and play around with really", and "We weren't really told the benefits of it. We were told that, yes, that information was there if we needed it, but not that 'This could really help you learn'".

For some these perceptions had clearly influenced how they interacted with the chemistry environment, with a typical comment being "If I thought it was as important as the lectures I'd have been spent more time using what was in the website". The uncertainty about the role of the environment probably also explains why all the chemistry students felt it was only intended to be used as a secondary resource to the lectures, and why on average the chemistry students used their NLE less frequently and extensively than the experimental and human factors students used their environments.

The uncertainty the chemistry students felt about their environment, and how to use it, also extended to several of the tools and features within it (Table 15). Their understanding about their discussion facility was not felt to have been aided by the information about this that was provided online. While this stated what the discussion facility was, and that it would be used in place of traditional seminars for the carbohydrate chemistry, no guidance was given on whether discussions would be initiated on a regular basis, what topics were up for discussion, whether the students could raise questions themselves, if the tutor would oversee and regulate the discussions, and whether and how the students were expected to respond to one another.

Unsurprisingly then, only a third of the chemistry students (n 5) agreed that the guidance given in the 'Information' section of their environment provided a clear explanation of how the discussion facility was to be used, with the rest unsure or disagreeing. Many of the chemistry students did indicate during the interviews that they accessed the discussion facility on at least a few occasions, and forty percent (n 6) agreed that they would have been prepared to participate in online discussion had any been taking place. For those who were, the barrier to participating was compounded by the lack of cues that might have been present had any discussion occurred:

> "I thought, well, I don't really know how to use it so I'll wait and see if somebody else uses it and then I can reply. But I didn't know if it was, you know, if you had a query you went onto the discussion board or if you just wanted to have a general

chat with other people in your course...I would have been prepared to use it. If there was a lot going on and there was something I could add I would have."

While for the chemistry students poor information about the pedagogical role of their environment and the discussion facility it featured respectively limited and prevented their use, a lack of adequate information on how to operate specific features of the environment had a similar effect. The Information provided fairly detailed instruction on using the 3-D Chime models, and just over fifty percent (n 8) agreed that this provided a clear explanation of how to work with them. The interviews suggested that many of the students who had actually read them were typically those who did purposively use at least some of the models, often going beyond studying them in their default form by using the various presentational options. For these individuals, having adequate technical instruction did seemingly inform good use of this particular feature.

TABLE 15: PERCEIVED QUALITY OF TECHNOLOGICAL INSTRUCTION - CASE STUDY 2

		N	SA/A	U	SD/D	Mean	St Dev
The information section provided a clear explanation of how the discussion facility was to be used...	CS2	15	5 33.3%	4 26.7%	6 40.0%	2.93	0.88
The information section provided a clear explanation of how to work with the Chime models...	CS2	15	8 53.3%	4 26.7%	3 20.0%	3.27	0.96
The information section provided a clear explanation of how to use the Chemical Modeller...	CS2	16	4 25.0%	3 18.8%	9 56.3%	2.63	0.96

Less valued were the instructions for the Chemical Modeller, which was to allow students to draw chemical structures via an interactive tool embedded within particular pages, and then submit the structure they had built for assessment. Very few understood the instructions provided, with fifty-five percent (n 9) disagreeing that these provided a clear explanation of how to use the tool. For those who had attempted to utilise it, they did so by trial and error: "I'd just play about until I'd finally got what I wanted drawn…I tried to use it to answer some of the questions. I did one of them after about three attempts, but then the next one I got to I just couldn't get it to work… The instructions were quite brief I thought. The instructions should have been a lot clearer."

Guidance on the educational role of NLEs and their features notwithstanding, clearly adequate technical instruction about how to actually operate the more interactive elements of their NLE was required to ensure the chemistry students were in a position to properly use some of the potentially knowledge-enhancing features at their disposal.

The emphasis that constructivist learning theory places on the authenticity of instructional environments, when applied to the activities that learners are required to undertake, favours those that are task or problem-based, often involve social collaboration, and which allow knowledge to be applied within the context of its development instead of only at the conclusion of an instructional episode. These principles apply equally to learning activities on which the student is being formally assessed (Jonassen, 1991b; Kerka, 1995; Shavelson & Baxter, 1992), with the aim being to foster the development of knowledge that will transfer easily to real-world contexts.

Most of the learning activities undertaken by the students in this investigation could to some extent be described as constructivist in nature. This applies particularly to the problem and case-based activities of the human factors module, and the practical application tasks completed by students in the experimental study. Of all the instructional factors that seemed to influence the nature and perceived value of the networked learning experience, the formally required activities appear to have been particularly influential in several key respects, not least in supporting effective learning and in helping motivate students to actually engage with their respective environments.

Over eighty percent (n 25) of the aforementioned students agreed that the tasks or assignments undertaken encouraged them to think about how the theoretical issues they had been learning about related to the real word (Table 16). As the students typically explained, the requirements of the activities were such that in order to complete them they had to not only comprehend what was presented in the subject material, but also question the relevance of what they understood to the task at hand. For the experimental study students this may have been in sourcing a web page that exemplified some aspect of the colour perception and design theory studied, or for the human factors students deciding which issues needed to be addressed in producing a solution to an organisational problem. This act of applying what had been studied in an authentic task context, essentially learning by doing, was highly valued: "With reading you can learn something, with graphics you learn more, and if you're actually doing it that's when you learn the best". Another student commented: "When I had to go on the web to look for myself I was trying to tie it to the theory...If I wasn't doing the activities, if it was just theory, it would be a case of cramming it in and not really thinking about it afterwards".

TABLE 16: PERCEIVED VALUE OF LEARNING ACTIVITIES – EXP AND CASE STUDY 1

		N	SA/A	U	D/SD	Mean	St Dev
The (tasks/assignments) undertaken enabled me to develop skill in applying the theory studied...	EXP CS1	20 10	25 83.3%	2 6.7%	3 10.0%	3.96	0.94
The (tasks/assignments) encouraged me to think about how theoretical issues related to the real world...	EXP CS1	20 10	25 83.3%	2 6.7%	3 10.0%	3.97	0.85
Having (tasks/assignments) to do periodically encouraged me to take an organised approach to learning...	EXP CS1	20 10	24 80.0%	3 10.0%	3 10.0%	3.80	0.89

The belief that the tasks and activities undertaken were more beneficial than traditional forms of learning activity would have been had several aspects to it. Beyond providing opportunities to apply and refine what they understood, one was that the realistic, hands-on nature of the activities allowed the students to develop the skills that were required to utilise their subject knowledge confidently, and over eighty percent (n 25) agreed that the activities had enabled them to develop practical skills in applying the theory studied. It was also felt, particularly by the human factors students, that the kinds of problem and case-based activities they found so valuable to their understanding would have been extremely difficult to do in a lecture-based rather than networked course "as you'd really need everything from the start, but in lectures you don't usually have most of what you need for doing assignments until near the end".

However, by far the most important additional benefit the human factors and experimental study students associated with the tasks and activities they undertook was that they were periodical, with deadlines for completion staggered throughout their modules, and that they were tied in with using different tools and materials. Eighty percent (n 24) believed that having periodic tasks encouraged them to take an organised approach to their learning, and in the interviews this was an issue almost all were vocal about. For some it was clear that periodic tasks requiring different features of the environment to be used aided managing studying and ensuring no relevant resources were overlooked: "They got you using it from the start and continuously through doing the assignments, and I'd look at different areas depending on what the assignment was. For the first two I would be using the study notes. For the digital documentary I'd be looking at case bases of previous documentaries and seeing what they had done".

Others discussed the importance of having periodic activities in more critical terms. Typical comments included "Without them it would have been a disaster. It forced you to say 'Right, get to grips with this because you've got to get this in'", and "because you are doing it within your own time, you need something to keep you using it and up to date. The temptation otherwise might be to always put that to the bottom of your pile of things to do". Furthermore, some students felt that having continual deadlines or milestones was of increased importance in fully online contexts, as lecture-based courses have a weekly structure of lectures and seminars in place that helps to ensure students are at least aware of where they should be up to, and which keeps them on track to a certain extent "because you know you've got to be seen at at least a few of them...even just to put in an appearance and get the notes". For these various reasons, there was a strong consensus that essays or exams, or any formal activities with end of semester instead of periodic deadlines, were not well-suited to networked learning and would tempt most students to "leave it all to the last minute".

Yet despite the largely positive role they played, the students were not entirely satisfied with the activities they were required to undertake. Specifically, the human factors students found the collaborative problem-based assignment they were to work on via their NLEs asynchronous discussion facility difficult in two key respects. Firstly, all work was supposed to take place within the area of the discussion facility set-up for each group. Partly this was to ensure all project correspondence was centrally stored, but also it was to make the contribution of each group member visible so the tutor could allocate an individual mark for participation in the problem solving process. Secondly, the end point for the collaboration was to produce a final written problem solution.

Although the human factors students had valued the reflective properties of the asynchronous medium for discussing relevant issues and sharing reference material, they found it to be limiting in the early stages of the project when the group had to allocate responsibilities, and especially when the content of the solution document had to be agreed upon and produced. As a result much of this type of communication took place face-to-face. One student estimated the online discussion within their group as constituting "less than fifty percent" of the communication that took place. Another described how "we found it hard that you've got a 500 word report to write, and it's not very much, but you still need to meet face-to-face to decide what's going to go into it and...online, well, there was suggestions but there was never anything decided on it".

The frustrations the human factors students felt with asynchronous discussion in relation to this assignment is certainly consistent with the negative feelings previous research has found in situations where students are required to use asynchronous communication tools for tasks that are more suited to responsive synchronous interaction (e.g. Newman 1996, 1997; Ocker & Yaverbaum, 1999), and may account for why almost all disagreed that their facility enabled a better quality of discussion than is possible face-to-face.

TABLE 17: PERCEIVED VALUE OF ONLINE ASSESSMENTS – CASE STUDY 2

		N	SA/A	U	D/SD	Mean	St Dev
The online assessments were a valuable means of testing my understanding of topics studied...	CS2	15	9 60.0%	2 13.3%	4 26.7%	3.33	1.11
Had I not undertaken the online assessments my understanding of the topics studied would be poorer...	CS2	15	7 46.7%	2 13.3%	6 40.0%	3.07	0.96
Having online assessments to undertake provided an incentive for progressing through the web site...	CS2	15	6 40.0%	1 6.7%	8 53.4%	2.80	1.08

On the chemistry module, learning was assessed entirely via the end of semester exam. However the chemistry NLE did feature formative online assessments. These took the form of multiple choice and other questions covering terminology, molecules, and types of reactions, and provided basic feedback in response to the answers given. The students were not required to complete the assessments, and relatively few did. However those that did found them beneficial (Table 17). Sixty percent (n 9) felt they had been a valuable means of testing their understanding, with almost half (n 7) believing their understanding would have been poorer had they not completed them.

Their uncertainty over the general purpose of their NLE and certain features of it aside, the fact that relatively few of the chemistry students used the interactive self-tests, and the entire group used their NLE less overall in comparison to the experiment and human factors students, can be attributed in a large part to the fact they were not being directly assessed for their networked learning efforts. Sixty percent (n 9) of the chemistry students agreed 'I would have used the discussion facility if contributions to online discussion were being assessed', while the entire group (n 15) felt that 'If our use of the NLE had been assessed I would have used it more extensively than I did' [10].

On the role played by their tutors in supporting their networked learning, the majority across the three research contexts were generally positive about this. The time tutors spent at the start of each module providing an overview of the environment was seen as particularly valuable, and for the experimental study and human factors students the ongoing support provided was mostly appreciated as being of an appropriate level. To the extent that e-mail was used to seek assistance, eighty percent (n 24) agreed that 'the tutor responded in good time when replying to my e-mail messages', and that "the quality of the feedback I received via the tutors e-mail responses was good'.

However, to varying extents most students from all three cohorts felt their respective tutors could have played a more active role in online discussions. The chemistry students were particularly critical in this respect. The only contribution to the chemistry discussion facility had been by the tutor, who at the outset posted a message consisting

---

[10] As the next chapter will show, assessment was particularly influential in how some students utilised their NLE.

of two concise specific subject-related questions. The common view was that the tutor could have done more to try and initiate an exchange, and as one student put it "if he'd seen that no-one had written an answer he could have written something else to try and start the discussion off. It was as if he didn't bother to look back at it. I suppose it was if he wasn't bothering with it then why should anyone else use it?".

In relation to the experimental study, the researcher acting as tutor had posted an introductory message to establish the threads for each activity-related discussion in the two NLEs with a discussion facility, but due to the parameters of the experiment had no subsequent involvement in the discussion. Yet this was something the students clearly would have appreciated, the thinking being that although the discussions were to be student-led the tutor could have played a useful role in confirming their progress and understanding. To an extent these feelings were shared by the human factors students, some of whom believed more guidance of this kind was required. As has been previously observed (Wilson & Whitelock, 1998; Jones, 1999), it was apparent in this respect that the opinion of the tutor was regarded as being more legitimate: "It was good to work on our own, but are any of us remotely sure we're on the right track? I reckon we all think we are, but we haven't been told 'Yes, you've done this right'. So there was a concern we could be way off...or making comments that are really relevant and it could be encouraging to know 'Look, you're away ahead. That's brilliant'".

4.2.6 AFFECTIVE PERCEPTIONS OF NETWORKED LEARNING

Although many of the students involved in this investigation were positive about the opportunities offered by networked learning, and how the main features of their NLE could support learning, these feelings were not shared by all. Although it is clear that certain instructional factors played a part in this dissatisfaction, some of the preceding findings suggest that matters of individual preference were also strongly influential, and it is in relation to the more affective aspects of autonomous networked learning that the students were found to be most varied in their general perceptions of the experience.

On the lack or relative lack of synchronous interaction that their networked learning involved (Table 18) overall opinions were fairly evenly divided. Forty percent (n 18) felt the lack of face-to-face contact with the tutor had been a significant problem, with the same number taking the opposite view. There was also a comparable split in relation to contact with peers. However, more students than the numbers who felt the lack of face-to-face contact was a significant problem believed they would still have benefited from a greater degree of it. Around sixty-five percent (n 30) were of this opinion on the issue of tutor contact, with twenty-five percent disagreeing (n 11). Regards more face-to-face contact with fellow students sixty percent (n 26) felt this would have been beneficial, twenty percent (n 10) did not, and the rest were unsure.

TABLE 18: FEELINGS ABOUT LACK OF SYNCHRONOUS INTERACTION

	N		SA/A	U	D/SD	Mean	St Dev
I found the absence/relative lack of face-to-face contact with the tutor to be a significant problem...	EXP CS1 CS2	20 10 15	18 40.0%	9 20.0%	18 40.0%	2.94	1.25
I found the absence/relative lack of face-to-face contact with fellow students a significant problem...	EXP CS1 CS2	20 10 15	20 44.4%	3 6.7%	22 48.9%	3.07	1.30
I would have benefited educationally from a greater degree of face-to-face contact with the tutor...	EXP CS1 CS2	20 10 15	30 66.7%	4 8.9%	11 24.4%	3.60	1.12
I would have benefited educationally from a greater degree of face-to-face contact with classmates...	EXP CS1 CS2	20 10 15	26 57.8%	9 20.0%	10 22.2%	3.49	1.06
Learning with the (NLE) involved a feeling of isolation I do not get in lecture-based courses...	EXP CS1 CS2	20 10 15	21 46.7%	3 6.7%	21 46.7%	3.16	1.30
Becoming motivated to learn is harder working alone via the PC than in a lecture-based course...	EXP CS1 CS2	20 10 15	22 48.9%	5 11.1%	18 40.0%	3.18	1.40

Responses to the post-experience questionnaires indicate that many of the students found working largely independently quite problematic. Almost half (n 21) found that networked learning involved a feeling of isolation not normally experienced in lecture-based courses, and on the issue of becoming motivated to learn again around fifty percent (n 22) believed this was harder than in lecture-based courses. However, large numbers indicated that they did not find networked learning to be isolating or motivationally difficult. This suggests some students were more at ease with networked learning than others, which general perceptions of the experience support (Table 19).

Around sixty-five percent (n 29) agreed that they found learning via their NLE to have been an enjoyable educational experience, with twenty percent (n 9) disagreeing. Opinions were more even on the issue of learning entirely online. Forty-five percent (n 20) believed they would not feel suited to networked learning used as the sole method of course or module delivery, although almost forty percent (n 17) held the opposite view. Interestingly comparable numbers to those who enjoyed and did not enjoy networked learning believed that they would (n 30) and would not (n 11) benefit, or have benefited, from increased access to networked resources in their other modules.

Perhaps most noteworthy is the varied opinions on whether the students would have learned more had their respective modules been delivered as lecture-based courses. Although a third (n 15) felt they would have and several (n 10) were undecided, the majority (n 20) actually disagreed. The interviews pointed towards poorly perceived instructional factors having played some part in individuals feeling negatively about the online delivery of their module, while those who felt positively about this partly did so due to the advantages they believed it had over lecture-based courses. Ultimately though, from the perspectives offered it was obvious many students simply did not consider themselves well matched to studying in predominantly or fully online contexts. This is probably reflected in how some self-rated their networked learning outcomes.

TABLE 19: PERCEIVED VALUE OF NETWORKED LEARNING

		N	SA/A	U	D/SD	Mean	St Dev
I have found learning using the (NLE) to be an enjoyable educational experience...	EXP CS1 CS2	20 10 15	29 64.4%	7 15.6%	9 20.0%	3.58	1.10
When/if used as the only method of course delivery I do/would not feel suited to web-based learning...	EXP CS1 CS2	20 10 15	20 44.4%	8 17.8%	17 37.8%	3.20	1.38
I feel I would benefit educationally from more access to web-based resources in my other modules...	EXP CS1 CS2	20 10 15	30 66.7%	4 8.9%	11 24.4%	3.49	1.31
I feel I would have learned more had the (subject material) been delivered as a lecture-based course/via lectures alone...	EXP CS1 CS2	20 10 15	15 33.3%	10 22.2%	20 44.4%	2.98	1.16

Against the three main topic areas covered in their environment, the students who participated in the experiment were quite varied in the confidence of their understanding (Table 20). In relation to the first area they were required to study there was a split between those who felt either very confident or confident (n 8), and those who had some confidence (n 9) in their understanding. As regards the second and third topic areas, slightly more felt very confident or confident in what they understood (n 11 in each instance), with comparable numbers expressing some confidence. Against each topic area two or three students had little or no confidence in their understanding.

In each of their modules key areas of learning, the human factors students were the group most confident in their learning outcomes overall. Almost all (n 8) indicated that they were confident or very confident in their general understanding of the subject area.

TABLE 20: CONFIDENCE IN UNDERSTANDING OF TOPICS STUDIED – EXPERIMENT

		N	VC/C	SC	LC/NC	Mean	St Dev
Colour vision and perception...	EXP	20	8 40.0%	9 45.0%	3 15.0%	3.30	0.98
Using colour in computer displays...	EXP	20	11 55.0%	7 35.0%	2 10.0%	3.55	0.83
Colour in the human-computer interface...	EXP	20	11 55.0%	6 30.0%	3 15.0%	3.50	0.89

VC/C = Very Confident/Confident; SC = Some Confidence; LC/NC = Little Confidence/No Confidence

In addition just over half (n 6) were very confident or confident in their ability to analyse and solve human factors problems, with just under half having some confidence, which is a fairly positive indication that the mainly problem-based learning approach implemented within the module was successful. Finally, all of the students expressed having at least some confidence in their ability to apply the knowledge gained within a professional environment. In no key area of learning for the human factors module did any student indicate little or no confidence in their understanding.

TABLE 21: CONFIDENCE IN MODULE'S KEY AREAS OF LEARNING - CASE STUDY 1

		N	VC/C	SC	LC/NC	Mean	St Dev
General understanding of the HFIM subject area...	CS1	10	8 80.0%	2 20.0%	0 0.0%	4.00	0.67
Analysing and solving human factors problems...	CS1	10	6 60.0%	4 40.0%	0 0.0%	3.60	0.52
Applying knowledge within professional environment...	CS1	10	3 30.0%	7 70.0%	0 0.0%	3.30	0.48

VC/C = Very Confident/Confident; SC = Some Confidence; LC/NC = Little Confidence/No Confidence

This was not the case for the carbohydrate chemistry students, and although almost seventy percent (n 11) felt very confident or confident in relation to the first of their four main topic areas, those who felt the same against the remaining three were always in the minority. Several students indicated having little or no confidence in the other three topic areas, with this group forming a slight majority in one instance. Again these findings are likely due to the comparatively poorer use of the chemistry NLE overall.

TABLE 22: CONFIDENCE IN UNDERSTANDING OF TOPICS STUDIED - CASE STUDY 2

		N	VC/C	SC	LC/NC	Mean	St Dev
Intro. to carbohydrate chemistry...	CS2	16	11 68.8%	3 18.8%	2 12.6%	3.81	1.17
Neighbouring group effects...	CS2	15	4 26.7%	6 40.0%	5 33.3%	2.80	1.21
Protecting groups...	CS2	16	3 18.8%	6 37.5%	7 43.8%	2.63	0.96
Glycoside synthesis...	CS2	15	4 26.7%	7 46.7%	4 26.7%	2.93	0.88

VC/C = Very Confident/Confident; SC = Some Confidence; LC/NC = Little Confidence/No Confidence

4.3 SUMMARY AND IMPLICATIONS

On reflection, at a minimum the findings presented in this chapter confirm that the students involved in the research undertook and experienced networked learning in many ways consistent with previous research findings. Most appreciated the opportunities for self-paced learning using a varied range of resources, yet many were uneasy about studying entirely online and showed at least a partial reliance on print materials. The need for explicit instructional guidance was evident, along with the need for appropriate tasks in relation to online discussion, and although most interacted with the main features of their environments some made more use of them than others.

Beyond this, of particular interest was the use made of supportive multimedia. Typically the focus of controlled experimentation, and rarely considered in relation to networked learning, it was found that these elements were heavily though variably studied under learner-controlled conditions. Little research to date has focussed on the extent to which students interact with the range of features that are typically found within NLEs, yet arguably this understanding is essential in order to establish the likelihood of students having actually benefited from interacting with them.

Unfortunately, while much previous work on the student experience has addressed how general aspects of networked course delivery were valued, with the exception of some investigations into asynchronous discussion, rarely are students asked directly about the different ways NLEs and their features supported their cognition. Through the answers and explanations provided, it was clear that many did actually have their learning and understanding enhanced through interacting with their NLEs and the hypertext course material, supportive multimedia, and asynchronous discussion facilities they contained in ways that are descriptively consistent with what the contemporary literature describes as the affordances of networked learning. This is not to imply that the potential affordances were realised by all, as the findings in this chapter have begun to suggest that many students have individual preferences that reduced the scope for them benefiting in particular ways. That this is despite most students generally valuing what networked learning offers only provides further evidence of the discrepancy between networked learning perceptions and practice that the literature review suggested. More importantly, it implies that the different ways in which individuals undertake and feel suited to networked learning may be a key factor in determining whether they are able to benefit from the affordances inherent within their NLEs. A deeper understanding in this area, the principal focus of this research, is sought in the following chapter.

5.0 APPROACHES TO NETWORKED LEARNING

The data considered in the preceding chapter shows, at a general level, that the experience of networked learning was variously perceived. Many students certainly felt that they benefited educationally from interacting with their respective environments, and often in ways consistent with the theoretical claims made for the affordances of NLEs. Yet there were also those who did not seem to experience some of the expected benefits, and who were not particularly positive overall about having learned in an autonomous networked manner. Although a number of instructional factors contributed towards how networked learning was undertaken and perceived, the elaborations that came through the interviews suggest the nature of the individual is a decisive influence.

In this chapter a deeper understanding of the diverse ways that the students undertook, experienced and gained in knowledge from networked learning is sought through an evaluation and application of the phenomenographic interview data concerning individual subjective descriptions of networked learning behaviours, rationales, and affective attitudes. The aim is to satisfy research objective (iii) by determining the apparent nature of distinct approaches to autonomous networked learning, i.e. the learning styles or strategies that different students exhibited and relied upon, and their subsequent influence upon the ability of the individual to effectively learn in this way.

5.1 IDENTIFICATION OF NETWORKED LEARNING TRAITS

In order to properly identify the different approaches taken, the phenomenographic method requires as a pre-requisite identifying and discerning between the range of networked learning traits and strategies that can be known about through the subjective accounts of the students. As such the method as applied to this aspect of the investigation, and the findings of this initial stage of analysis, are considered first.

5.1.1 APPLICATION OF THE PHENOMENOGRAPHIC METHOD

The data obtained through the interviews was analysed using the phenomenographic procedure described in Chapter 3. In attempting to arrive at an understanding of the diverse ways networked learning was undertaken and experienced, comments were initially grouped into broad thematic areas reflecting the general topics of discussion for the interviews. These broad themes concerned how students: attempted to learn the content of their mediated course material; interacted with the other constituent elements of their environment; managed their networked studying; and felt about their personal suitability to networked learning. Iterative re-reading of the excerpts within each theme enabled the researcher to differentiate between sets of comments similar in their core qualitative meaning, and the essence of this shared meaning provided the basis for the categories of description pertaining to networked learning traits presented below.

Categories of description are the first of two products of a phenomenographic analysis. Based on the key phenomenographic assumption that there are a limited number of ways in which any phenomena can be understood to have been experienced, the researcher then sought to conceptualise the nature of the relationship between the various categories of description. In phenomenographic terms the product of such a conceptualisation is "the outcome space", i.e. a hierarchical classification scheme reflecting an assumed natural order in the various ways of experiencing a phenomena (Marton, 1994, 1998; Marton & Saljo, 1997). The outcome space for this research is therefore the classification of approaches to networked learning that will be presented.

5.1.2 THEME 1: LEARNING THE MEDIATED SUBJECT AREA

As a starting point for understanding the different ways that students approached networked learning, the range of strategies employed for appropriating knowledge from networked course material was considered. Two aspects relating to this were deemed important. The first, relevant to the reading of any academic text, concerns what in the content of the prose the student was directing their attention towards. The second, relevant to the autonomous reading of hypertext-based material that affords the learner control over their own exposure to course content, concerns what in, or how much of, the material was selected for studying. During the interviews, the individual was required to elaborate on their learning in these respects in relation to the core subject material they were provided with, e.g. the material in the Theory Base in the context of the experiment. Student interaction with the other main elements of their environments was addressed separately in the interviews, and treated as a separate theme for analysis.

Through the iterative analytical process, major differences in what seem appropriately termed as the 'focus of reading' and 'breadth of reading' presented themselves. Regards the former, a clear distinction could be made based on what learners described as their main intention when reading the material, with the primary focus either on understanding, achievement, or memorisation. Table CD1 illustrates the categories of description, with typical comments, pertaining to 'focus of reading'. Those who were identified as reading for understanding concentrated on appropriating knowledge about the concepts, theories and ideas presented, and essentially described themselves as pre-occupied with discovering the meaning behind that discussed in the text. In theoretical terms they were basically seeking procedural knowledge through deep processing. As indicated, for some this involved note-taking and other studying strategies, such as consulting additional material, that were geared towards optimising their understanding.

For those students categorised as reading for achievement, the concern about which they were most conscious was learning what they perceived as necessary for successfully completing their assignments and other assessed work. This did not preclude a focus on understanding, but limited what parts of the course material the individual attempted to understand as they intentionally concentrated their efforts on maximising their assessment performance. This distinction between those who read to understand rather than achieve is encapsulated in this comment from an individual who did the former: "I was thinking 'How does this fit together?', 'Is there a thread through it all?'...Instead of thinking 'Oh, what is coming up in the exam?', because for me it is not relevant. It is actually understanding what is in the material I have been given to study" (EX03).

Just as those reading for achievement could focus on understanding, they also adopted rote learning methods where this was seen as appropriate pre-assessment preparation: "I used the Glossary quite a bit...because I could remember the basics but I often couldn't remember what the word or name for it was. It was recapping what I'd gone over for doing the tests, trying to memorise them" (EX09). However, the use of rote learning strategies alone identified those individuals categorised as reading for memorisation. These students apparently concentrated exclusively on trying to remember what they saw as the key facts and terms, sometimes even employing deliberate strategies for reducing course content to an easily learned set of core facts.

TABLE CD01: FOCUS OF READING

Reading for Understanding
"I felt it was a good idea to know about the whole picture...Instead of learning it off by heart so I could, you know, read it by rote, I tried to understand the concepts. In that process maybe I did learn a bit off by heart, because your brain remembers things, but I tried to just understand the concepts. What it was talking about, that was really more important" (EX20).
"I'll skim read first of all, and then go back and read through it thoroughly. If there's bits I don't understand or are important I'll highlight them. I'll even write it down, write it out and think 'Well, what do they mean?'. And if from that one source it's not clear I'll look at another book on the matter, or a journal article or something, and try and dig it out in my own mind what it means...I've just done that all the years I've been studying, and that applied to the web site too" (HF10).
Reading for Achievement
"I would never try and learn a full chapter but I would try and learn the main bits out of the chapter, so that's what I did with the [web-based] module...I was using it as part of, like, learning to study for the exams. I was looking at the past paper questions to see what sort of things came up. I was also referring to my [lecture] notes to see what stuff was in the notes, because there were some things in the [web-based] module that went a bit further so I was like, well, there's no point in learning something that is beyond where I need to go...The whole point is that I feel that I've got to pass the exam" (CC10).
"I wrote notes because there's a lot to relate to...then I read over them to try and understand. Well, to remember the terminology with the concepts. I was trying to relate it to one another, because in the tests I would see something and think 'Well I know what that is but I can't remember the example'. So doing the notes helped me in the tests...In the second section I knew what was expected, so I thought 'Right, now will that be asked? You know, something with more than a few options. Like the four types of [computer] displays. I found myself saying 'I'm going to learn that because I know there's gonna be questions on it'. So I did try to learn what I thought I needed to know for the tests" (EX17).
Reading for Memorisation
"I printed it out and took it home then wrote it out myself. Because that's the best way of learning for me, if I write it out myself...You could maybe sort of see questions forming out of what was there, but you weren't exactly sure what you'd be asked...so I'd just pick out the main points and then summarise them until you can learn them at a really basic level and remember them. Try to memorise my own notes" (EX19).
"It was quite a lot to take in at one time...I tended to do it all in one go. I'd rather just get it all done at the same time, even if I had to read it a few times...Is it the Outline or the Glossary that's got all the main [definitions]? Yeah, well things like them, like words and terms. I concentrated more on that, thinking that they were the important things. Trying to remember the terminology and what it meant" (EX04).

The emphasis was clearly not on understanding or reading for optimal achievement, but instead on coping with their respective learning or assessment demands: "I'll just try and memorise it all. But I don't think that's a very effective way of learning because if you're just memorising something for an exam then it's not long term, you remember it for the exam and that's it...but it gets you through" (CC08). Similarly the student (EX04) indicates above that they read entire sections of material in single sittings, despite finding this practice problematic, and all the while concentrated on the most prominent key terms. In theoretical terms, these students were surface processing for declarative knowledge.

It is worth acknowledging at this point the obvious similarity between the reading for understanding, achievement, and memorisation networked learning traits identified, and the respective intentional aspects of the deep, strategic, and surface approaches to studying we know of through the established phenomenographic research (e.g. Entwistle & Ramsden, 1983; Entwistle, 1997). From the earliest work in this area to present it has been accepted that the intention of the learner when reading an academic text, or undertaking any formal learning endeavour, encapsulates something elemental that permeates many of the traits defining their overall approach. This will also be seen to apply to how individuals approach autonomous networked learning [1].

In relation to breadth of reading, i.e. what or how much within the course material was selected for studying, individuals were discernable based on whether they deliberately read across the entire body of material, opted to read particular sections only, or read minimal amounts in a relatively non-discriminatory fashion. However the issue is more than simply one of quantity read due to the mindful, or not, deliberation on the part of the learner just hinted at. Table CD2 illustrates. Those who read through all their course material typically described doing so in a linear and systematic manner, starting with the introductory materials and routinely interacting with supporting multimedia and other features as they were presented. Associated with this was an effort to allocate adequate time to their progression through the material: "I used it for a few hours each time…I read all the material that was on it, and I did all the mini-tests, and tried to look

[1] The possible relationship between approaches to conventional and networked learning is discussed in 5.4.

over all, well, just everything" (CC02). All of this seemed directed towards the learner appropriating from the material as in-depth knowledge as possible, hence the emphasis placed on addressing domain basics first and resolving any misunderstandings.

This is markedly different from the rationale that led some learners to be classed as selective in their breadth of reading. In interacting with their respective NLEs, these individuals had decided only to work through whichever sections of the material covered topics on which they expected to be formally assessed. All other content, after an initial perusal, was excluded from the learning undertaken. As indicated, for one of the human factors students this meant discarding the core subject material itself because they felt unable to reference it to support the content of their reports [2]. This was selective reading in the extreme. More typically, as exemplified by the student (CC06), it involved reasoning about what within the material to concentrate on. For this student it was from a well-informed position as they had consulted past exam papers.

In addition to those who either fully or selectively read their networked course material, others described themselves as having been very narrow in their breadth of reading. Symptomatic of this was reading centered on one or two sections of material, mainly the introductory ones, or which covered an arbitrary amount of content throughout. Possibly underlying this, and unique in comparison to those who read fully or selectively, is that students who read minimally seemed to lack clear strategies for governing the breadth of their reading. Skim reading was dominant, and often distanced from a serious attempt to learn from the material: "You kind of just scan over the screen as opposed to sitting and reading it...You weren't actually reading it to learn, I was just

---

[2] The human factors students would not necessarily be expected to look at all the mediated material as the topics of their assessed work varied depending upon their allocation to assignment groups. However the environment was subdivided into distinct subject areas, so this issue could be considered in context.

reading it and thinking 'Well, that's there, yeah'" (CC11). It was also evident that little or no thought had gone into considering which parts of the material were worth reading.

TABLE CD02: BREADTH OF READING

Full Reading of Material
"I read through it on the screen and tried some different features, you know, chime models and things like that...And I did it for all the material, it wasn't just some of it I used. I did use all of it...I just started from the start and kind of worked through them, and then went back to any, like, looking at past papers and seeing anything that came up regularly, and then going back to them if I didn't quite get them. I was doing that. So I'd looked over all the notes from the start, and just working from the start" (CC05).
"I started with the introduction and worked all the way through...I'd normally be able to work be able to work through one section. I'd normally go on for about an hour or so and just go through it. I'd look at the chime models and I'd look in the glossary if there was something that I didn't understand" (CC13).
Selective Reading of Material
"A lot of the material that was on the website I didn't use at all...I highlight any notes, but the notes that I was highlighting wasn't the notes from the web pages. It was references that I went and found. Because how do you reference the notes that are on a web page? If you've got to incorporate them into any of your assignments, you know, is it plagiarism? It always seems like it, because you tend not to reference lecture notes...After I printed them I almost discarded them. I didn't really look at them" (HF06).
"I didn't really use it for the participating groups or the glycoside synthesis...I felt that some of the protecting group stuff was a bit too much involved. I did feel that it went too far, from what we'd done in the lectures. I know that we were supposed to look at that as well, but from looking at the past papers I didn't feel that we needed to know a lot of what was in it, so I tended not to look at it" (CC06).
Non/Minimal-Required Reading of Material
"I don't think I read the theory part of it in depth at all....I printed them [the study notes] off and I've got them at home but I don't feel that I read them. I didn't take the time to read them fully through or anything like that. Maybe sometimes I'll flick through and try to find a topic for some of the things we had to hand in but I didn't make a point of sitting and reading through the whole thing" (HF05).
"I didn't really concentrate as much on the studying side of it...It was like you know how if you're flicking through a book but just reading a few lines, 'Oh, right. That doesn't look like much' and you just sort of move on. That's really what I was doing...I had a wee skim through it all but I sort of stayed to more the carbohydrate part, like the very beginning of it, because I never really got as far through" (CC15).

Although what the individual focused upon in the act of reading their networked course material can be seen as separate to what in the entire body of the material they selected for reading, the findings suggest a relationship is likely. This is reflected in a shared emphasis on meaningful knowledge appropriation that is central to both reading with a focus on understanding and reading across the full breadth of material. In a similar vein, reading with a focus on achievement and reading selectively have the common concern of assessment performance, the only difference being that this is instantiated at two different levels of interaction with the course content. Then in the coping, rote-learning characteristics of reading for memorisation a link with the skim-reading, fairly directionless interaction with material that characterises reading minimally can be reasoned. If this begins to suggest a certain consistency across different networked learning traits, it is one borne out by the findings on how individual students interacted with the other constituent elements integrated within their respective NLEs.

5.1.3 THEME 2: INTERACTING WITH CONSTITUENT ELEMENTS

Beyond their hypertext-based course material, the students in each research context had access to various NLE features with the potential to support their learning. Depending upon their environment, these included supportive visual and interactive multimedia, asynchronous discussion facilities for communication and collaboration, and external web links for pursuing further reading. Through the interviews an insight was sought into not only how learners felt they benefited from interacting with these constituent elements, for which general findings have been presented, but also the particular ways in which individuals were consciously aware of having utilised them. Of interest in this respect were issues surrounding how, i.e. the manner and extent of usage, and when, i.e. the situation or occurrence of usage, for the features at their disposal. As became apparent during the analysis process these factors were often interdependent.

In evaluating the interview excerpts relating to this theme, what emerged was the realisation that students were interacting with the other elements of their environments in ways broadly comparable to the pairs of focus and breadth of reading traits that seem consistent with one another. That is to say both the manner and occurrence of usage could be seen to reflect a primary concern with either fully understanding the subject area covered in the environment, doing well in the assessed components of their networked learning by concentrating on what they felt they needed to understand, or no more than coping minimally with the learning to be undertaken. Individuals were categorised as having had full, selective, or non/minimal-required interaction with a particular constituent element. The essence of each category as derived from the interview data on usage of supportive visual multimedia is shown in Table CD3.

This constituent element, a feature of the chemistry environment and two versions of the experimental one, comprised the static, interactive and animated graphics that were embedded within the course material and intended to convey or elaborate upon the explanations provided in the basic textual content. What distinguished those learners who interacted fully with this feature is that they purposively studied any supportive multimedia elements they encountered during their reading, and in doing so had clearly been intent on appropriating as complete an understanding as they could of that being depicted. This was associated with a high degree of self-awareness that they were not simply engaged in the act of looking: "Basically there's got to have been a point to it to have been put in, that's what I think, so I keep looking at it until I get the point why it's there, really...I did actually study them to see exactly what it was trying to prove to me" (EX01). Where supportive multimedia was in some way interactive, e.g. could be rotated or visually altered, this was also apparent through these individuals being consistent in not merely studying these elements in their default state: "If I came to one then I'd basically study it until I could see what it was about, and if I was to change anything, or push play or whatever, then I'd do all that a few times...You actually participated and changed the stuff yourself. You actually saw what happened" (EX11).

Selective interaction with supportive multimedia was also characterised by an interest in understanding the object or process shown but, as with the individual reading for achievement, only for those aspects of the subject domain they felt they needed to understand. Thus, as shown below, the student (CC04) reports having interacted with most of the 3-D molecule models in the chemistry environment, but to the exclusion of those depicting structures they had enough knowledge of, and only used the presentational features to examine aspects of structures they perceived a need to attend to. Similarly the student (EX15) indicated having often attempted to seek an understanding by reconciling the content of the text and supporting graphics within their networked environment, but again only when they perceived a need to do so.

TABLE CD03: INTERACTION WITH SUPPORTIVE VISUAL MULTIMEDIA

Full Interaction with Feature
"I looked at all the graphics. Whenever there was one I made a point of looking at it , the pictures and the animations...Well not just looking as in, like, only looking, but studying them. Trying to understand the point or, you know, process. And then when I felt I'd gotten it then move on to the next part" (EX14). "I would say I studied all of them [the interactive diagrams]...That was just what I did when I was working through all the pages. They could definitely give you more information about what was happening in a reaction or a mechanism...and why certain molecules were reacting at specific sites within a molecule because you could see things happening at certain parts, you could run a mouse over and a box pops up. It helps you get an understanding of the process that's happening" (CC03).
Selective Interaction with Feature
"I studied most of them [Chime Models]. I didn't do them all though. Some I felt I didn't need to look at because I understood it and I felt in some the time was getting on...Slightly [used the presentational features of the Chime Models]. I liked them to be generally the same so that I knew what part was what, and so that there was a kind of a recognition of the specific groups and stuff like that...but I found in some cases that it was good, especially if you were, like, changing a functional group. It was quite good for that because you got to see how it reacted differently and how the molecule changed" (CC04). "Yeah, I looked at most of them. Well, I did for the things I didn't understand anyway, to try and see what it was showing me. And quite often I'd read the text, look at the graphics, and then it would become a bit more clear once I'd looked at the graphics. Then I might read the text again...(EX15).

Non/Minimal-Required Interaction with Feature
"I looked at a few of them , and the ones to play I always played...I always pressed the buttons. I just usually played them once to see what they did. I think there was a couple I played more than once...I looked at some of them [static graphics]...I probably paid more attention to the ones you could play...I didn't look at all the ones in the second section because I didn't look through all of it" (EX13). "When you were looking at it you thought, well, 'This is good. You can see it all in 3-D'...I didn't really work with any of them [Chime Models]. But it was good that you could actually do that, you know, and if you did then it would have been good being able to see it in the 3-D and being able to rotate it " (CC11).

As for the individuals who were categorised as having non/minimal interaction with the supportive multimedia in their environments, they simply either did not use these features at all, or in interacting with them employed what could be regarded as the equivalent of skim reading text. The emphasis, as encapsulated by the student (EX13), was on looking over rather than pointedly studying the content of the visual. This distinction between learners who fully or selectively interacted with supportive visual multimedia and those who were non/minimal in their interaction also extended to interaction with other supportive multimedia featured in the hypertext material. In the context of this research the issue relates specifically to the use of the interactive assessments in the chemistry environment. For example whilst one learner who interacted fully with this feature commented: "I did all the assessments I came across...the best thing to do was see if you know it, but instead of just going on if you get it right put in all the other answers to see why they're wrong" (CC16), a learner at the other extreme commented: "I never used any of the assessments. Like I clicked on one or two of them, but I never actually tried to seriously use them" (CC15).

It would seem reasonable that the concerns reflected in the different focus and breadth of reading traits would manifest themselves in how learners interacted with constituent elements, like supportive visual multimedia, that are integrated within the course material itself. However they also applied to how students interacted with those features that were adjunct to the course material, including the asynchronous discussion facilities that the students were either required or given the option to use. As can be seen in Table CD4, those who interacted fully with their discussion facilities frequently exploited the reflective properties of the medium to carefully consider and understand the views of their peers before contributing themselves, and in between took time to reflect on and compose their own thoughts. For the student (HF04), participating in the group problem solving assignment on the human factors module, this process involved substantial literature research. They were also pro-active in following many of the web links in the discussion so as to source potentially relevant material, even going beyond the topic of interest by looking at what those tackling different problems had located (in a pro-active effective "vicarious learning" manner as outlined by Mayes et al, 2002).

TABLE CD04: INTERACTION WITH ASYNCHRONOUS DISCUSSION FACILITIES

Full Interaction with Feature
"I always read what everybody else had put up first rather than just going and typing my thoughts in. Part of that was to check that you weren't putting up the same URL, you know, but obviously to see what the chain of thought in the discussion was...I knew there was the time restrictions but it was done at my pace. Doing it face-to-face might say things on the spur of the moment then realise 'That's not quite what I wanted to say', whereas doing it with the discussion group you could sit and think about it, read other people's thoughts, and clarify your own thoughts before you put anything down" (EX05). "I read the Conference Space, printed out what people had written, saw their suggestions, went away to the library, and then I sent a suggestion back maybe two days later after I'd done a bit of research on what had been said...You could look at other group's [discussions] as well, so you could get information from all the postings that were sent. I mean everybody had their different links, so you could look and say 'Well, they've got one on information overload. I haven't seen that'. OK, click, then you've got that information as well...I used the links a lot, they were very good" (HF04).
Selective Interaction with Feature
"There were a couple of occasions when I would think about it overnight and consult notes and things. So you can go away and read up and then decide what you want to say...I didn't follow all the links [in other contributions]. I looked at the one's that appeared relevant to whatever was being discussed. The way I seen it some people had different ideas and I just followed the one's that I thought were in line with the assignment...It was useful for finding more information for the assignments" (HF02). "I went into it to see if anyone had written anything, but there wasn't ever anything. I'd used chat facilities before, and students would write in with questions and other students would answer them. Then the professor would come and write a definite answer. I figured it would be something like that...I checked it the times that I did use the program but I don't think I would have written anything. I just didn't feel like the discussions would be that integral in the course. But I if other people had been discussing things then I certainly would have read them to see what they had to say about it" (CC02).

Non/Minimal-Required Interaction with Feature
"I don't think I did think much about it [what I wanted to say], but probably if it was, we were actually assessed, then I would take more time to think about what we were saying and, like, I'd probably go away and think about it first and then go back to the Discussion Area and type it out then. Well, I would, but this time because it was just a wee exercise for us you were just typing it straight in. But if it was assessed then I definitely would be thinking more about what I was going to put into it" (EX04). "Maybe I should have contributed a bit more...There was a few things that I put in but I don't think I put in as much as other people...because I'm not as keen as other people...It was like 'Oh, I must put something on because [tutor's name] will see it. So you have to have your name down the list somewhere. That was an incentive for using it because he was supposed to be checking up on it" (HF05).

Less conscientious in interacting with their discussion facilities were those who used them selectively mainly to serve their formal learning requirements. This practice took various forms across the different research contexts. For example student (CC02) regularly accessed the discussion facility that was part of the chemistry environment, despite always finding no contributions there, and was willing to read what other people thought of the topics posted for discussion even though they personally did not regard them as important enough to have considered contributing themselves. In the context of the human factors module the student (HF02) indicated that they used the medium to reflect on the content of their own contributions only on occasion, and as regards following the web links in the contributions of their peers only ever looked at those that they saw as directly applicable to completing the assignment being undertaken.

In the context of the chemistry module, in which participation in online discussion was optional, there were instances of genuine non-interaction involving individuals who had never logged on to the discussion facility and so were presumably unaware no discussion was occurring, e.g. "I didn't check it once. I just sort of boycotted the whole thing" (CC15). In the context of the human factors module and experimental study, in which participation in discussion was obligatory, those categorised as having had minimal-required interaction tried only to satisfy the basic criteria for participation. Hence the student (EX04) indicates above that they wrote and dispatched their messages in one act, partly because they had to contribute but were not assessed on content, whilst the student (HF05) displays a similar rationale in stating that their main motivation for contributing to online discussion was the tutor monitoring levels of participation.

Although e-mail contact for tutor support was rarely used, the major exception being the students in the experiment who sent their activity answers to the researcher-as-tutor, where it had been used similar distinctions to those observed for participating in asynchronous discussion emerged. There were individuals who took time to think about exactly what they wanted to say to the tutor, and consequently reflected upon and sometimes filed away the feedback received, and then there were those individuals altogether more passive in their use of the medium: "With e-mail you can go and find out the answer first, and then get back to the tutor...I didn't really think about it when I was doing the activities. I just put it down and then sent it off" (EX18).

As one last example of the different ways that the students interacted with the constituent elements of their environments, the use made of the external links to additional subject-related materials on the web provides further insight. In both the human factors and carbohydrate chemistry environments external links were presented separately to the core course material, and listed in dedicated pages the learner had to deliberately retrieve [3]. For those who interacted fully with the external links, the main emphasis once again seemed to be on optimising their knowledge of the subject area: "If I was trying to understand something, for example physical ergonomics, then I would go through all the links in the ergonomics section...I've been through them all because I couldn't get my head around that. So if I couldn't understand something that was a good reason for following up on the links" (HF01). The contrast with the student

[3] This is not to imply any potential effect on their usage, but to point out that in these particular environments the learner could not simply come across the external links in reading the text of the main course material.

interacting selectively was also as expected: "I checked them all. I looked through them all but didn't really use many of them…I judged that they weren't particularly relevant to the piece of work I was doing" (HF06). As for the non/minimal-interaction individual, typical comments included "I'm ashamed to say I didn't follow any of the links…I didn't do any further reading at all. No doubt other folk will have" (HF07).

5.1.4 THEME 3: SELF-MANAGEMENT OF NETWORKED STUDYING

Phenomenographic research has shown that something fundamental pertaining to how a student learns can be understood from the manner in which they appropriate knowledge from instructional material. However it has also consistently highlighted the influence that the strategies individuals use for managing their learning have upon determining their approach to studying. One important aspect of the strategic approach, for example, is organised study methods. Consequently it was considered important in striving to understand the different ways students approached autonomous networked learning to gain an insight into the strategies or traits that governed or were associated with studying in this kind of instructional context. During the interviews this was facilitated by asking the learners to reflect on what if anything they did to prepare themselves for the learning they were to undertake, how in the absence of a conventional course structure they organised the time spent networked learning, and what as independent learners they did if any problems in understanding were experienced. It became evident that the traits associated with these issues could be seen to represent distinct methods of self-orientation to networked learning, time management, and resolving difficulty.

Regarding self-orientation, it emerged that most individuals had employed one of three strategies prior to or at the point of addressing the impending learning, with each directed towards a specific aspect of their course (Table CD5). For one group of learners, the concern was to familiarise themselves with the subject domain at the outset. This involved using the initial sessions interacting with their NLE to read through all the course-related material at an adequate depth of detail to form an overview of the domain, and so promote a sense of direction to guide their subsequent learning. As was typically commented on the expected benefits of this practice: "It gave me an idea of where I was going, what I was doing, and also about the deadlines and things like that. So it definitely set it up...I think if you're prepared that way you're probably more receptive to taking more in. You know where to go from there" (EX07).

Although the main focus of the student who familiarised themselves with the domain was the subject area for study, this was not, as alluded to, mutually exclusive from an orientation towards assignment requirements and deadlines. Yet although becoming alert to this is arguably a necessary part of learning in any instructional context, for some students it was a familiarisation with task that had been the main objective of the self-orientation process. Initial periods of interaction were largely dedicated to reading over course outlines and assignment specifications describing the work to be completed, whilst any interaction with the actual subject material was minimal. Also often reflected in a concern with task familiarisation was a focused exploration of the networked environment itself. Familiarisation with the layout and structure of an NLE is presumably gained from looking over the subject material within it, but for some students actually orientating themselves towards interacting with the environment was an issue. This was most evident within the context of the chemistry module. Given that many of these students were relatively new to using web technology, and were provided with a fairly sophisticated resource, it is likely this form of familiarisation was seen as preparation for the broader task that was the networked learning experience.

TABLE CD05: SELF-ORIENTATION TO NETWORKED LEARNING

Familiarisation with Domain
"The first week I read through everything. All three sections. I just read it all to see what it was all about, you know, get an idea. And then went back and then just, the first two weeks, I just stayed in section one after that. I wanted to get a general idea of what it would all be about first of all...because then it kind of puts everything in perspective as well once you were learning it going along" (EX11).
"The first couple of times that I went on, I sort of went back and forward to see what was there. Read through it all to get an overall view and also a feel of the actual site itself...When it came to doing the key issues report there was one [section of the NLE] on politics of training that didn't really come into our key issues. I didn't use that although I knew it existed because I'd had a look at it initially. So I'd taken an overview of the site and from that my use of it was determined by the key issues report and things like that...For me it was quite good because it gave me an overview of what to expect" (HF10).
Familiarisation with Task
"The first day I had a look at it just to become familiar with it, then I printed out the Outline an put in my diary all the dates by which an activity had to be done. So therefore I could look at the printed information to say 'This is the activity I have to do'...I had a look at the contents page and printed it out. I just had a look over the first theory section. I don't like to look so far ahead. I've always been, with things that I do, 'Look, that's not what you're working on so why worry about it now?" (EX09).
"I did go in it a couple of times at university [as opposed to home], and I didn't do anything then, I just flipped through it and saw what the chime models were and everything...There's an introduction and it tells you about the glossary and the models and all the different things. And that's basically all I went through the first time, just to get a brief overview of what everything was before I even started on the introduction to carbohydrates...Then I knew what everything was, that I could use the glossary at any time, and that I could use the chime models to get a fuller view of 3-D structures" (CC10).
Reading Only As Required
"I didn't bother [looking through the NLE]. I just started off with section one, page one, and then went to section two when I needed to do section two...It's handy to have it there to know what you're going to be doing but in the web-based, having the Outline, was it completely necessary? I didn't really read it at all, but for a lecture module the Outline is useful because the way I study...you say 'OK, I'm gonna do that essay question', and then you show up for those lectures as there's no point going to any others" (EX02).
"I just got what I needed straight away on the first one [section], and then only looked at the other sections when I came to do it...I did look at the Outline but it was only actually to see what was coming that week that I was looking at it" (EX19).

Finally, a third group of individuals were discernable on the basis that they had made no attempt to self-orientate, either to domain or task, prior to undertaking their networked learning. Instead they read the subject material as they were required to, starting at the beginning and progressing when necessary: "I only looked at the first section [during initial session]. The first time I saw sections two or three was when I done it, on that week" (EX18). In extreme cases, as illustrated in the table, reading as required resulted in a complete failure to even look at administrative information containing task descriptions and deadlines. Only slightly more prepared was the individual who looked at this information as they commenced learning on any particular week. As an aside it is interesting to note that neither of these students completed all the activities set.

What the practice of reading as required might suggest is that some individuals, in addition to being poor at self-orientation, may also find time-management problematic in autonomous networked contexts. This is supported by the interview data on this particular aspect of managing networked studying, which identified learners as having adopted one of two particular strategies for allocating time to interacting with their environments. They either studied consistently and periodically for the duration of their course, or used what is perhaps best termed a 'just-in-time' strategy (Table CD06).

Although there is some variation amongst just how organised those categorised as studying consistently actually were, the salient feature of this trait was evidence of applied self-regulatory ability. This presented itself in several ways, for example the student (EX06) who accommodated their learning on the two days a week when they were able to dedicate sustained periods of time to studying via their NLE. Then there is the student (EX11) who undertook networked learning whenever the opportunity arose, and to the extent they were spending more time on this than for their conventional classes. What these students and those like them share is an apparent willingness, linked with good to high motivation, to commit to working autonomously in an organised manner: "With web-based learning you have to decide that you're going to do it and so you get down and do it. That's probably why I timetabled things" (EX09).

TABLE CD06: TIME MANAGEMENT

Consistent Studying
"My pattern for reading the website was set by my own personal routine...Thursday I'm not in, Wednesday we're in for a very short time, and Tuesday we've got an absolutely packed day. So Monday and Friday are the only times when I've got convenient spaces, so although my learning was only based on those two days I tended to try and spend longer on it than I would have done if I was looking at it once every day for a short time...I never really go 'Right that's me learned that'. I will actually make an effort to do it...I never say 'I'm not going to learn that, I'm going home'. I don't work like that" (EX06).
"Usually I would find time during the day or else in the evenings...I'd end up spending more time on that in a week than I would for any other modules, because the other modules I'd only take an hour and a half maybe an hour forty-five at the most. I probably spent more time than that on the web-based learning. I just found it more interesting because I could do it whenever I felt like doing it [and] was deliberately saying 'Well, I've got free time now. There's no point wasting it, I can do my web-based learning'" (EX11).
"You could work at your own pace. I could come in, use it, do the work, go home, finish it at home. Whatever I wanted to do...I'm quite good at working at my own pace. Sometimes I leave everything until the last minute but not very often, so I usually get it done with time to spare...I've always got that date in my mind 'Right, it's due in then'...I just worked away like I usually do. I get all my stuff ahead of time. I've usually got everything a few weeks before so it's lying there just ready to get going" (HF08).
Just-In-Time Studying
"I dunno if everybody's the same but I sort of done things just beforehand, just before each test or activity...I done it as I had to do it, at the period rather than spinning over learning it at the time" (EX10).
"I didn't really look at it very much because I didn't have to. So I kept on thinking 'Oh, I'll do it later', and then didn't do it for very long. You don't really look at it unless you have to. At least, I didn't. Then I thought 'I'd better look at it because I've got that test tomorrow'...I haven't really looked at the last bit [of material] in detail yet. I've had a quick look through it. I'm doing the test tomorrow" (EX13).
"I had a tendency to leave things right to the last minute, like printing out all the notes at the end and that kind of thing. I'd say you have to be more motivated...I think basically because you're kind of left on your own a lot more and you can put it off, keep putting it off, which I tended to do" (CC06).

Conversely, those individuals categorised as having undertaken networked learning in a 'just-in-time' manner were all identifiable through one common practice - they only interacted with their environment to access material for studying, or to undertake formal activities, immediately prior to an exam or assignment deadline. Consequently, and as their comments indicate, the period of time these students had in which to study with their material, or complete activities, was greatly reduced from that which would otherwise be available. On the difference between those who are self-regulating networked learners and those who are not, a student who was the latter stated: "You need the self-discipline to learn something every week. I don't and so I haven't...When the assignments had to be handed in, that's when I learned things" (HF05).

Because autonomous networked learning is a largely independent endeavour, it was thought reasonable insight into how individuals approach this might be found in the strategies they employed to any counter problems they had when trying to appropriating knowledge from the mediated course material. Once again the phenomenographic analysis implied three distinguishable traits. All, perhaps unsurprisingly, encompassed re-reading strategies. Yet beyond this there was evidence, albeit more tentative than some of that previously discussed, of apparent qualitative differences between groups of individuals [4]. Essentially this was based on whether in attempting to resolve the difficulty experienced the learner had consulted sources out with the environment, internal to the environment, or simply opted to leave it unresolved (Table CD7).

Those sources considered to be internal to the environment included the students and tutors contactable via asynchronous communication facilities, or in person as an extension to the environment, and the external links to web resources provided in the environment. The individuals categorised as having consulted external sources described sourcing for themselves relevant textbooks, academic journals or electronic materials on the web. As evident the emphasis of this is on arriving at a personally meaningful understanding of the topic in question, hence the concern with seeking to examine the issue from a new angle or perspective.

[4] Relatively few learners reported encountering any significant difficulty, and although there was sufficient subjective description forthcoming to facilitate a reasonable analysis there is less data to infer from in comparison to the other categories of description identified.

TABLE CD07: RESOLVING DIFFICULTY

Consulted External Sources
"The way I tend to work is if I read something and don't particularly understand I go back and read it again, or then I'll look at another source of material and see the way it's described...Like cognitive ergonomics. To me physical ergonomics is straightforward, but cognitive I wasn't entirely sure about so I actually got a few psychology papers and they talked in quite a lot of detail about, you know, the processes of the brain...And I found that because they approached it from a different angle that 'Oh right, this is quite good', and I understood it better than the way it was put in the [NLE] material" (HF10). "I'd tend to go and look it up in a book to see if I could understand it from a different point of view, and if I was still really stuck either ask my friends or see the tutor who was taking the course...Amongst my friends I got help with that, but I didn't go and see [lecturer's name] about anything...I'd have another re-read, again using the notes from the lectures because it's another view, another way of looking at it. And also in textbooks, see if I could get my head round it that way" (CC09).
Consulted Internal Sources
"I read it over and over again. Thought about it, tried to see if there was any more information I could read about which could explain why things are like that...I sent off one e-mail to [the tutor] because there was something that wasn't thoroughly explained in the text, and that was not exactly what we were supposed to be taught but it was related, and [the tutor] sent me back an e-mail and explained it" (EX03). "I had to make an appointment with [tutor's name] just to check that I was actually going about it [an assignment] the right way. And basically speaking with your peers. Finding out 'Oh, what are you doing for assignment two?', 'Oh, I'm doing this', 'Oh good, that's about right then'. Just that sort of thing. So talking with your mates and then speaking with or e-mailing the lecturer" (HF03).
Left Difficulty Unresolved
"I like talking with people to find out what they're thinking about stuff...It helps me learn, having people to speak to...If I didn't understand something then I'd see if anyone else knew about it...Well I didn't, but I could have. When I didn't understand something I just didn't understand it. I just left it." (EX18). "I read them [topics covered] a few times, you know. I'd go back maybe the next week and read them again...When there was a bit I didn't understand I would read it again then if I didn't get it just think 'Oh well, I'll see if it's being covered in the lecture', but if it hadn't I just left it until it was" (CC08).

Beyond re-reading text, the individuals who consulted internal sources seemed to principally seek clarification on specific points, or even assurance that they were progressing along the right lines. More worrying were those students who, despite perhaps showing awareness of potential strategies they could utilise, ultimately left any difficulty encountered unresolved. How much insight these findings alone offer might be questioned, but they are certainly reminiscent in nature of some of the other networked learning traits identified, particularly where a dichotomy between understanding and coping is implied.

5.1.5 THEME 4: PERSONAL SUTABILITY TO NETWORKED LEARNING

It was recognised from the outset that the networked learning experience would comprise not just how students interacted with their environment, but also those beliefs about networked learning they formed as a result of this interaction. As such the final area explored during the interviews concerned the affective attitudes of the student, i.e. their likes, dislikes, and preferences in relation specifically to the networked learning undertaken, but also to the idea of autonomous networked learning generally. It became apparent that the findings in this area, which broadly pertained to feelings of personal suitability to networked learning, addressed two distinct but related affective traits. The first concerns how the individual felt about their ability to study autonomously in networked learning contexts, and the second their personal instructional preferences.

Regarding their ability to study autonomously, it was evident that for the majority this was determined principally by how much instructional support they felt they required to learn effectively in an autonomous networked context. The need for instructional support could be seen on two levels; support required for comprehending the mediated subject area, and support required for the successful management of networked learning effort. Based on their own perceived need for these types of support, individuals were either categorised as being fully self-governing, as requiring guidance, or as requiring structure in this particular aspect of personal suitability to networked learning.

As demonstrated in Table CD8, students who came to be considered as fully self-governing had no discernable need for either form of instructional support. There appeared to have been two main reasons for this. Firstly they felt both able to and comfortable with managing their own studying, and as this self-motivation had obviously manifested itself in consistent and organised learning there was no need for any kind of instructional assistance in responding to this particular demand of autonomous networked learning. Secondly these learners had clearly accepted independent studying as a defining characteristic of networked learning, which coupled with their ability to work independently meant they had no problem progressing with their studies in relative isolation, in the real-time sense, from tutors or peers. Associated with this was an awareness that asynchronous communication facilities were at their disposal, and an apparent willingness to use them as the standard, even preferred, means of conversing with the tutor in a networked instructional context. It was also clear that students who could be considered fully self-governing on the above grounds felt themselves to be highly suited to networked learning, and found learning in this way enjoyable. In this respect they tended to comment: "I'm comfortable with web-based learning and what it involves" (EX01), "It fits the way I like studying" (CC09).

Those categorised as requiring guidance were more selective in which aspects of networked learning they felt suited to, and although many indicated that they enjoyed or experienced benefits associated with self-paced learning, and could work effectively this way, these students were united in their desire to have increased interaction with the tutor in order to aid their comprehension. Their thinking was that having the tutor more readily available might allow them to develop a better understanding of topics than they would working alone, and could serve simply to clarify those isolated points on which some level of misunderstanding was expected to inevitably occur. There were various ideas about how this support could be facilitated, for example consultation periods throughout or at the conclusion of the course, but what was important to most of these individuals was that it must occur face-to-face. E-mail and asynchronous communication facilities were seen as valuable for facilitating the guidance-level support desired, but there was a reluctance to have all such contact with the tutor online. The factor most often underlying this was a perceived need for the kind of interpersonal interaction to which they had become accustomed: "I need the face-to-face contact with lecturers. That's what I'm used to and I don't think that will ever change" (HF09).

Interestingly, few of those who exhibited a need for guidance in their networked learning had particularly negative feelings towards having worked in isolation, in real-time, from their peers. This is not to say that interaction with other students was considered unimportant, as it wasn't, but for guidance in comprehending the mediated subject area it was certainly seen as less important than real-time interaction with the tutor. As one student commented: "You could talk with the people in your class until the cows come home, but unless it's [covering] what's needed there's no point. At the end of the day the people in your group aren't marking you, the tutor is" (HF04).

For those students who were neither fully self-governing in their ability to study autonomously, nor who simply sought guidance with comprehension, it was apparent that extensive instructional support would need to be in place before they could attempt to undertake networked learning in even a semi-focused and organised manner. Self-motivation once again presented itself as a key factor, and as regards the form of instructional support required, it was obvious that in order to become motivated to study in a networked context, these individuals needed the type of structured learning activity normally associated with 'traditional' courses. Thus, rather than undertaking networked learning at times determined by themselves, which encouraged the repeated delay of studying, a pre-determined timetable would have increased the likelihood of some sustained learning having occurred.

TABLE CD08: ABILITY TO STUDY AUTONOMOUSLY

Fully Self-Governing
"It's [networked learning] a way I like to work and I'm good at doing it. I'm also reasonably good at setting deadlines for myself, so I don't need to have a set of deadlines in front of me...For tutor contact I had the e-mail so I didn't feel that I was missing out on anything there. It's the way I normally contact tutors anyway...[Lack of] student contact I wouldn't say was a huge problem...I do work well alone anyway, so it wasn't a problem in a course I understood fairly well on the first reading" (EX14). "I organise my time, so I would decide 'Right, I'll do the web-based learning now so I can get the activity done and get on with other work'. So you can fit it in amongst other things, and spend us much time on it as you need...The tutor contact wasn't an issue. I had e-mail if there was any difficulty, which is better because you don't have to rush about trying to find the tutor...I didn't think about it [lack of peer contact]. I didn't feel it was missing...I did feel suited to it. I did enjoy web-based learning" (EX16).
Requires Guidance
"You need the back up of lectures and seminars...In lectures sometimes it gives a broader picture from which you can get ideas, because the lecturer has said things that have triggered a thought in me. I don't think you get that reading on your own...You could do it at your own pace which always helps, so it was mostly alright...Perhaps a consultation period towards the end might have been useful. You could talk to the tutor in-depth about it...As regards having contact with the class it would have been nice to know what they thought of it. It might have made you understand it a bit more, but also I think that it's valuable to do it yourself because you concentrate more. So perhaps slight contact, but nothing too big" (EX20). "You can do it any time you wanted...that's a really good advantage. I've enjoyed it more than having to sit for twelve lectures going 'Oh, this again'. It's just the interaction with the lecturer I've missed...If you're looking at the web page and there's something you don't understand you couldn't turn around and say 'What does this mean? So that's what I missed, just a reinforcement of what's in front of you...Even though it's written down there's going to be a couple of things you won't understand, and the lectures seem to explain them better...It [no face-to-face contact with tutor] feels really strange...I probably did feel more isolated" (HF03).
Requires Structure
"I hardly ever looked at it, but if you're going to lectures you have to go to them. Well I go to the majority anyway, because you know you've got to be seen at a few... I think being in a normal class does make you work because you see other people doing the work and think 'Oh, I'd better do it as well'...I think if someone told me 'You have to do it now!', that would have made me look at the web site more. Having deadlines just makes me do the work. I think 'Oh, it's got to be done now so I better do it'...I don't think it [web-based learning] suits me because I don't really look at it. I need that incentive" (EX13). "I don't think I'm able to understand it and learn just through the computer alone...You need to have the teacher with you or I wouldn't have been able to, because I find it hard just to go and read books and learn from the book. I need the teacher to tell me everything what you're doing...I'd need to be forced to go. Like hours set aside for the class to go as a whole and do it rather than just saying 'Go in your own time'...If he'd had said 'You've got to do this by next week otherwise you won't follow' then you would have went and done it yourself. That would have gave you the motivation to look at it" (CC11).

The presence of the tutor during these hypothetical sessions may have aided these students further, as many indicated that in comparison to networked learning "there is more motivation as far as lectures go because they'll probably notice more if you're not doing it or if you're not there" (EX12). Also associated with the issue of increased tutor presence, and an important difference to those who require guidance, is that learners seeking structured support were more likely to indicate a preference for the tutor actually describing topics and tasks to them, i.e. providing explicit instruction rather than further explanation as required.

A similar logic to that underlying the perceived need for tutor presence also applied to the issue of interaction with fellow students, as it was often felt that when working alongside peers in a class situation, observing them studying served as a cue to do likewise. Finally, and in common with those individuals who were seen to undertake networked learning in a 'just-in-time' manner, the students found to require structural instructional support relied heavily upon deadlines in order to motivate themselves to learn. Formal assessment deadlines were seen as important, although it was also clear that informal deadlines or pointers toward expected progress communicated by the tutor could also have played a role in encouraging these individuals to study between formal deadlines. Unfortunately such pointers tended not to be communicated by the tutor, either verbally or electronically [5], and as this student explained: "I know [the tutor] was going to test us at the end of it, but they weren't actually saying to us 'Look, you've got to do this', so we had to take it off our own back to go and do it. So we had to put a lot of effort into it, but I never really" (EX19).

Unsurprisingly those categorised as requiring structure consistently indicated that they did not feel suited to networked learning, and did not particularly enjoy it. The fact that what these students disliked or found problematic about networked learning was largely based on how it differed from traditional instruction will be seen as important in a number of ways. However the first is in addressing the second aspect of personal

[5] With the exception of the human factors module, in which e-mail was occasionally used for this purpose.

suitability to networked learning that emerged during analysis. Although closely related to the issue of self-perceived ability to study autonomously, this concerned what, having experienced networked learning, the instructional preferences of the students were. This was explored during the interviews by asking the students to reflect on what, given the choice between lecture/tutorial-based and autonomous networked instruction, they would favour as a method of course delivery. It should be noted that the findings relating to this issue are based largely on the idea of completing a single module [6].

It is perhaps fitting that the traits associated with instructional preference are discussed last, as essentially they relate to the varying degrees of willingness that this predominantly novice group of networked learners held towards learning in this way again [7]. The basic distinctions that emerged were between those sharing a preference for networked learning, for hybrid instruction integrating networked and lecture-based methods, or for traditional lectures and tutorials. Tutorial or seminar-style discussion with fellow students was felt by the majority to be critical for effective learning in most situations, although there were different opinions on how to enable this.

The students who expressed a preference for networked learning tended to justify this in terms of being able to work at their own pace in developing an understanding of the mediated subject area. Often this was associated with an awareness and concern that during lectures they were not taking down all the information necessary for a full understanding, and in the act of taking notes were prevented from engaging in the act of learning itself. For these reasons lectures were considered educationally ineffective and

---

[6] No-one felt autonomous networked learning was suitable as the sole method of instruction for more than one or two modules in a full-time undergraduate course, principally due to the increased time on learning that is required when there is no direct instruction and interaction with tutors and peers is asynchronous.

[7] Although there were differences across the three research contexts in terms of experience using PC and internet technology for educational purposes, no student had interacted autonomously with a networked learning environment that was the sole or principal method of instruction (as detailed in Chapter 3).

dispensable: “If I had a choice I’d go for a web-based one [module]. The lectures aren’t that important for learning because you only really go there to get the notes you need to let you study…so the only difference would be that you’re getting the notes from the web site whenever you need them” (CC05). However whilst a networked environment was favoured above lectures as the principal method of obtaining and interacting with the core subject material, tutorial or seminar contact with tutors and peers was still highly valued. There was a high awareness that some tutorial sessions demand being situated in a classroom or laboratory setting, for example where physical or technical skills were being practiced, but this was accompanied by an openness towards discussion-based activities occurring online. This reflects the general feeling amongst these students that networked learning, or some aspect of it, always has a potential role to play in supporting their studies: “I think it can add something to almost any course. Some of our courses have only had a Newsgroup and that's helped, so it can bring something to anything even if it doesn't take over the entire module” (EX14).

What distinguished those with a preference for hybrid instruction was their belief that a networked environment would be of most value to them when supporting the lecture-based delivery of course material. The consensus was that by having the basic lecture notes available in advance online, more effective learning and note taking would occur during the lecture as the student would already be orientated towards what the lecturer was planning to cover. The recognition that a supplementary networked resource could facilitate more organised and efficient studying within lecture-based courses also meant that features like external links to further reading, or asynchronous communication tools as a complementary means of communicating with the lecturer, were generally valued. In common with those found to require guidance in order to study autonomously, however, students with a preference for hybrid instruction were negative about the prospect of not having lectures, or any form a regular face-to-face contact with the tutor, as they believed they could learn more effectively when the tutor was explaining core topics to them. For some students with the hybrid preference, an additional concern was with seeking cues on their assessed work: "The mixture of the two is probably the best...Web-based it gives you an overview of what the content is, but they point you in the right direction in lectures about what might come up in the exams...They might say 'That's not important, this bit, but this is important'. You don't get that when you're going through it online...I think that [mix] would be much more helpful" (CC10).

Whilst those expressing a preference for networked learning were consistent in their shared feeling, there was some variation amongst those who would prefer hybrid instruction. Although most explained this preference in terms of how a networked resource could help them be more efficient learners, there were a few whose rationale could be described as less conscientious, and who justified their preference for hybrid instruction purely in terms of not having to attend every lecture, and then being able to compensate for any they did miss. Yet a more pronounced diversity in underlying reasons for individual instructional preferences was apparent in the descriptions of those who favoured traditional instruction over both networked and hybrid instruction.

On the one hand, the dominant feelings amongst this group concerned the same perceived lack of self-motivation that affected those found to require structure in order to learn autonomously. Basically these students would prefer the lecturer to play the active role in communicating course content, rather than seeking and seeking to understand it for themselves, and in imposing a formal course structure rather than them having to assume the responsibility for regulating their own studying.

TABLE CD09: INSTRUCTIONAL PREFERENCES

Preference for Networked Learning
"I prefer web-based learning to a lecture. I can take it in when I want, whereas with a lecture often you're trying to take down word-for-word what's being said so you do miss out a lot. Yeah you might miss it first time on the web page but you can go back, and if you don't understand it the second or third time you've got the option to e-mail...I could see the seminar being more beneficial. It helps reinforce and clarify ideas, so a sort of medium might be needed...No course would be taboo for web-based learning. I mean it depends on your attitude to learning. I prefer to have it there to work at my own leisure. So you could do that with every subject, and then have an option to e-mail or discuss it with somebody" (EX07). "I don't think I would want lectures on their own. I'd go for a combination or just web-based. But when you have someone talking to you sometimes they give you more detail, like they might say something that makes you understand it a bit better than if it's just words...So I think all the factual information, all the notes, could be given out on the web but it would be helpful to have tutorial periods...In lectures I don't think I take in everything being said if I'm busy writing. I would rather have a full set of notes instead of trusting myself to write it all down. So I'd prefer a generated set of notes then work periods" (CC02).
Preference for Hybrid Instruction
"Something between having access to a site and a tutor lecturing would be optimum for me...When I'm in lectures I take notes, and when I'm writing I can't focus on what the lecture is saying ...Combined I have the best of two worlds. The material provided on the web would be the basics taught in the lecture, and I'd be prepared for the lecture and know what the lecturer is talking about because I can then take more efficient notes...The social aspect is important, so also having other students to discuss the things we're learning with...Usually when I'm studying I try to have some feedback from other persons, some kind of conversation about what we were doing, and that was hard. I missed that aspect" (EX03). "In one unit the tutor gives us web sites to look at. She has the lecture notes, the background stuff, on the web site and you bring those with you and take notes from that, you know, she looks at the headings and you take notes. Underneath it there's links to different web sites....It encourages you to go on to the appropriate websites by looking at the lecture notes. And I would say having web sites as a background thing is good but not as the main lecture material, like the notes you would have taken, no. You have to take notes to clarify it, and because a lecturer knows their subject they can clarify it for you" (EX20).
Preference for Traditional Instruction
"If we'd just had good quality lecture notes and good quality lectures that would've probably been better...I'd prefer to have lectures, I wouldn't be very happy if it was just on the internet. Just because it's what you're used to really, and also, I don't know, I always feel that I learn more about things in a lecture when somebody's actually explaining it to you and knows what pace people should be working at, rather than having to be motivated yourself and have to work at your own pace yourself" (CC06). "I think I learnt a lot from it, but I wouldn't like to do a full course just on the web. Maybe it's the unfamiliarity with it. I know lectures and I know how to use them for studying for exams, where as with the web I don't think I'm that confident...because in lectures you're taught all that you need to know, and especially the points that are important, where as in the web you decide which points are important. And if you get them mixed up, or you think a point's important that isn't, you could spend a lot of time doing something that might not come up...Knowing that there are so many side chains on other parts it I would be tempted to go off on side chains, go to other sites and learn things that aren't relevant" (CC04).

Lectures were therefore desired as the sole method of interacting with the core subject material partly because: "In lectures you get new information every week. So you have to attend. But you know the stuff in the website is always going to be there and will be the same...which is why I left it all to the last minute. It comes down to time-management. Because you've got no-one pushing you on there's always something better to do" (EX15).

On the other hand, there were a few individuals who would prefer traditional instruction not because they felt unable to motivate themselves to learn in a networked context, but simply because they felt unable to learn as effectively as they can on a lecture-based course. For the student (CC04), as indicated above, part of this lay in their perceived inability to judge for themselves what information in a networked environment they should attend to in order to gear their learning towards exams. And even though students with this instructional preference did not necessarily feel ill-equipped for autonomous networked learning, they did typically indicate that "Probably the lectures on their own would be best for me...It's just because I'm used to it, because I know how to study that way" (CC07). Such comments obviously raise the question of whether an individual can develop in their ability to be an effective networked learner, and can come to know how to study in that way. This issue will subsequently be addressed, but first it should be questioned whether the range of networked learning traits identified do actually suggest the existence of a limited number of discernable ways in which the students approached autonomous networked learning.

5.2 APPROACHES TO NL IN THEORY AND PRACTICE

If the premises of the phenomenographic method are accepted, and the method has been appropriately applied in collecting and analysing data, then in the context of this particular investigation it should be possible to reflect on the subjective descriptions of experience provided by the students in order to provide a plausible explanation of the general diversity in approaches to autonomous networked learning. Then by considering the students in light of this understanding, it should be possible to determine both how legitimate an explanation of approaches to networked learning this is, and the influence of individual approaches upon networked learning effectiveness.

5.2.1 CONCEPTUALISATION AND IDENTIFICATION OF APPROACHES

The form that the explanation sought through application of the phenomenographic method takes is the previously discussed "outcome space", which is essentially a hierarchical classification scheme reflecting the different ways a social phenomena, in this case autonomous networked learning, was experienced. Although it is accepted, consistent with the interpretivist paradigm, that each individual will experience the same phenomena in their own unique way, an important phenomenographic assumption is that a basic similarity between groups of individuals will allow a limited number of different ways of experiencing a phenomena to be identified. In terms of producing the outcome space this involves the researcher conceptualising what the relationships between the categories of description - themselves representing different ways in which specific aspects of the same phenomena were experienced - might reasonably be. The intention is to produce an outcome space representing a recognisable reality pertaining to the phenomena of interest (Marton, 1994; 1998; Marton & Saljo, 1997).

As evident within the categories of description discussed, it does appear there were clearly discernable differences in how students undertook and experienced the aspects of autonomous networked learning that were investigated, with typically three distinct learner traits seemingly associated with each aspect of the experience. For many of the categories of description that emerged through analysis, essentially all those that addressed interaction-based aspects of networked learning, the fact that three traits were consistently identified may not be coincidental because each trait could be seen to reflect one of three underlying concerns that governed how students attempted to appropriate knowledge from their networked environment. At a broad level, the students were principally concerned either with developing the fullest possible understanding of the mediated subject area, with tailoring their studying towards formally assessed learning, or with merely coping as a networked learner.

These concerns were immediately obvious in what students focused on when reading the networked subject material, with some striving to comprehend the concepts and theories being explained, others making decisions about and attending to any content they linked with assessed work, and the final group attempting to memorise facts and terminology as a means of getting through their course. The essence of these traits were unsurprisingly also present in the descriptions the students provided in relation to their breadth of reading, with some individuals having read all the material systematically and progressing only when they felt they understood a topic, some opting to read only those sections that covered topics directly relating to assignments, and some skim reading a minimal amount of material that was often non-purposively selected.

Furthermore the concerns with understanding, achieving, or coping associated with the focus and breadth of reading traits, and particularly the full-through-selective-to-minimal interaction with course material relevant to breadth of reading, were observed as the principal factors that delineated the diverse ways learners had interacted with the other features in their NLEs. Learners categorised as interacting fully with constituent elements would, for example, study all the multimedia elements presented, exploit the reflective properties of asynchronous discussion to consider in detail the contributions of others and the content of their own, and follow any links to external web resources as a matter of course. That their primary concern was developing an in-depth understanding of their subject area was obvious in the detail of their accounts, such as the high self-awareness of having studied, not passively looked at, the multimedia elements. In comparison the learners categorised as interacting selectively with such features described paying most attention to asynchronous discussion messages that related to assignments, only following external links to further reading that covered issues they anticipated needing to write about, and only studying multimedia elements that related to something they didn't already understand, or had not understood from the textual content of the material they chose to read. Finally, those categorised as interacting minimally with constituent elements exhibited strategies similar in nature to those observed for the 'reading for memorisation' and 'minimal' breadth of reading traits. If they did even interact with any constituent elements they certainly applied themselves with the least cogency, looking at rather than actually studying the content of multimedia, contributing to asynchronous discussion only to satisfy the basic formal requirements for doing so but without using the reflective properties of the medium, and consistently failing to follow any external links to further reading materials.

As regards the strategies individuals employed for managing their networked learning efforts, whilst a concern with understanding, achieving or coping is perhaps more obvious within the different ways individuals studied using the materials and resources at their disposal, they also seem to permeate the traits pertaining to this aspect of networked learning. Thus in the act of self-orientating themselves towards networked learning, a clear distinction could be made between those students who concentrated at the outset on forming an overview of the subject domain to guide their subsequent learning, versus those who only read the administrative materials relating to the task at hand including assignment specifications, course outlines, and information about the environment. Although those who exhibited an orientation towards domain or task, or understanding or achievement, shared a concern with preparing themselves prior to commencing learning, this was not true for those categorised as 'reading when required'. These students only ever read the subject and administrative materials for the first time when imminent deadlines demanded they start studying. To suppose that the practice of only reading online course materials immediately prior to deadlines reflects a strategy for simply coping with networked learning seems reasonable, as in common with the other 'coping' traits identified a lack of cogency about how to learn effectively is apparent. If this had been present it is not evident within the behaviours reported, e.g. reading for rote memorisation and minimal use of constituent elements, which like this trait seem occupied with doing no more than is necessary to get through the course.

As for how individuals attempted to resolve any difficulty encountered during learning, beyond simple re-reading strategies, the distinction was between those who consulted sources out with the environment, those who only consulted sources within the environment, and those who left difficulty unresolved. What apparently drove those who were willing to go beyond the environment to consult other online and print resources was the desire to examine issues from new and different perspectives, which suggests a concern with understanding the domain was dominant. Less apparent was what led some individuals to seek to resolve the difficulty they encountered within the confines of the environment. There was no stated concern with achievement on their part, and given that the categories of description for resolving difficulty are based on comparatively less data than for the other traits identified, and that it could simply be that internal resources satisfied these individuals needs, then it is somewhat contrived to suppose one. However some connection with a focus on achievement may exist. Certainly from what can be seen of the behaviour associated with an orientation towards achievement, with the student using only the resources they considered directly relevant to the assessed work, it would seem unusual for an individual with this particular focus to consult sources not formally linked to the course. Lastly, at the opposite end of the continuum, a concern with no more than coping with networked learning is once again suggested in the behaviour of those who did encounter difficulty when studying, but beyond re-reading the core course material made no attempt to resolve it.

Contemplating the range of traits so far considered, it does seem reasonable to make a fundamental distinction between individuals who, in undertaking networked learning, are focused on understanding the domain, satisfying the formal learning objectives as best they can, or meeting the minimal requirements for course completion. This distinction manifests itself across several aspects of networked learning behaviour, and where any facet of the understanding-achieving-coping trichotomy is not immediately recognisable, there are grounds for inferring that it could well have been at play.

The point of departure from this pattern comes when considering the remainder of the traits identified, including those relating to time-management which was the last of the three strategies for managing networked learning investigated. On this issue just two traits were distinguishable, the difference being between learners who undertook what was categorised as 'consistent studying' as opposed to 'just-in-time studying'. Those who studied consistently all had some means of planning or regulating their time spent learning so it was dispersed throughout the module, and strived to ensure they always had enough time to do what was required. This was in direct contrast to those who regulated their learning by impending deadlines, and only interacted with their environment to read the material or complete tasks immediately prior to deadlines. In some reported instances studying began the day before, or on the day of, a deadline.

Yet despite only two time-management traits being identified, there are good reasons for assuming a relationship between these and the other interaction-based traits. A connection between those who studied just-in-time, and those who in terms of self-orientation to networked learning read the mediated material only as required, has already been postulated. If this is expanded to consider whether there is a link between just-in-time studying and the other coping traits identified, a sound assumption would be that an individual who routinely undertakes networked learning activities immediately prior to deadlines would not have time to do anything other than interact minimally with their environment. They may then be more likely to read for rote memorisation, be narrow in their reading breadth, have no more than a cursory look at supportive multimedia, fail to participate reflectively in online discussion, and find themselves in a position where any difficulty they encounter has to remain unresolved. On the reverse, effective time-management of networked learning is arguably a pre-requisite for any individual seeking to learn effectively whether their main concern is understanding or achievement, but particularly where it is the former if they are to read all the course material in-depth, actually study supportive multimedia elements, be reflective in online discussion, follow up on external links or seek additional material, and have time to resolve any difficulty they encounter. So although the two time-management traits do not by themselves convey anything about the underlying concerns that apparently informed how individuals attempted to learn online, there is a strong likelihood of an association between organised studying and understanding or achieving on one hand, and just-in-time studying and no more than coping with networked learning on the other.

Based solely upon the apparent nature of and relationships between the interaction-based traits identified, some formal classification of approaches to networked learning might be feasible. However this would be incomplete without accounting for the affective aspects of networked learning. In focusing on feelings of personal suitability to networked learning, the phenomenographic research revealed traits on the related dimensions of 'ability to study autonomously' and 'instructional preferences'. Once again three distinct traits were identified for each affective aspect, although admittedly in relation to instructional preferences there was a degree of variation between those exhibiting the same basic traits that was not observable for the other traits.

On their perceived ability to study autonomously online, students were categorised as fully self-governing, requiring guidance, or requiring structure. Self-governing individuals had accepted independent studying as part of networked learning, and so had no problem with working in relative isolation from tutors and peers. They also felt confident and able in managing their own learning. In short, neither form of instructional support - for comprehension or studying - was believed to be required, and these individuals enjoyed and felt entirely suited to networked learning. Those who required guidance enjoyed networked learning to an extent, mainly appreciating the self-paced aspect, but were notable for their desire to have had increased contact with the tutor to support knowledge appropriation. For most it was clear that this would have occurred face-to-face as an adjunct to online learning and communication, partly because they felt most suited to receiving guidance this way. A more pronounced reliance on traditional instructional methods was expressed by the learners who were regarded as requiring structure. By their own admission these students found it hard to motivate themselves to undertake networked learning, and felt they would have benefited in the quality and organisation of their learning from having had timetabled sessions at which the tutor would provide direct explanation of the subject area and explicit guidance on learning activities and expected progress. Without the type of structured learning normally associated with lecture-based courses, and specifically the motivating presence of the tutor, these individuals had no real incentive to learn and were conscious that, as a result, they studied far less than they should have. Unsurprisingly, less of this group enjoyed or felt suited to networked learning.

The pre-occupation with conventional course delivery methods apparent within the autonomous studying ability traits of many students also provided a basis for individual instructional preferences. Those who preferred networked learning as the principal course delivery method cited the benefits of self-paced learning, and believed this allowed for a fuller understanding of the subject area than lectures, which they mainly saw as a means of obtaining basic course material. Associated with a preference for networked learning was a willingness to undertake it for any parts of a course for which it was feasible. Less coherent in their underlying rationale were the students who would opt for either hybrid or traditional instruction. The former believed that traditional lectures were optimum for understanding partly as they felt a need for tutor elaboration as required, but that having this supported by the networked delivery of material would allow for more efficient learning during lectures. For some with this preference an important aspect of lectures was seeking cues on formally assessed work, although there were a minority who would welcome the availability of material online so they need not attend lectures. Finally, most of the students who would choose lecture-based over networked or hybrid instruction indicated they would do so largely because of self-motivational issues. Having lectures to attend would have ensured at least some regular exposure to course content, whereas having information online resulted in the delay of studying. This was indicative of a general desire for the lecturer to be in control. On the other hand, there were a few who preferred traditional instruction simply because it is what they are accustomed to and felt they could learn most effectively from.

In terms of how these affective networked learning traits might contribute to differentiating amongst individuals on the basis of an overall approach, first of all an interrelationship between self-perceived ability to study autonomously and course delivery preference can be assumed. Both sets of traits share similar levels of concern with self-motivation and the need for tutor intervention, and reflect how positive individuals felt about networked learning in both practice and principle. Certainly it seems logical to think that the student who enjoys and feels well suited to networked learning is more likely to indicate a preference for this form of instruction, just as the student who feels unsuited to it would not. As for a potential relationship between the affective and interaction-based networked learning traits, it is possible to infer that this also exists.

This becomes most obvious in considering the fairly directionless, disorganised character of the various coping traits identified, and the essence of the affective traits indicating a need for structure and preference for traditional instruction. What permeates them all, from reading with a focus on rote memorisation and minimal interaction with constituent elements through just-in-time studying and the perceived inability to learn autonomously, is the suggestion of individuals functioning at the base level of networked learning endeavour, and who lack or fail to employ the appropriate study skills and motivation to do otherwise. Some consistency might also be attributed to the traits seemingly associated with a focus on achievement, and the affective traits for requiring instructional guidance and preferring hybrid instruction. Those who tailored their learning towards maximising achievement, or at least with the formal learning objectives in mind, interacted with their environments selectively through reading the material they saw as directly relevant to the assessed parts of their course, also based their interaction with constituent elements on what they thought they needed to know, and in orientating towards networked learning immediately familiarised themselves with the contents of administrative course materials. It is in this concern with core curriculum that a link may rest. Certainly viewing the lecturer as the 'official' source of knowledge is one of the factors associated with a perceived need for instructional guidance and a preference for hybrid instruction, and although there are other factors at play, with some learners simply feeling unable to learn as effectively without face-to-face tutor guidance, viewing the lecturer in this capacity seems to signify a similar logic to that behind the apparently related achievement traits. This may explain why a few individuals indicating a preference for hybrid instruction saw lectures as an opportunity for the practice of 'cue-seeking' [8]. Finally, as regards the link between the remaining interaction-based and affective traits, it is perhaps sufficient to conclude that those who are the most purposeful in interacting with their environment - and who seek understanding through utilising all resources as fully as possible, manage their time effectively, and even source knowledge out with their NLE - are most likely to feel able as networked learners and have no problems with studying this way.

In reflecting upon the range of traits identified, and the relationships and commonalities that connect those associated with different aspects of autonomous networked learning, what the phenomenographic analysis points toward is the existence of three diverse ways of approaching networked learning that in their basic nature reflect a focus on either understanding the mediated subject area, on tailoring learning towards formal

---

[8] Although these observations are perhaps tentative grounds for assuming a link between these sets of traits, further evidence strongly suggesting that the selective interaction most often associated with an achievement focus is related to a need for guidance and preference for hybrid instruction is forthcoming in 5.4.

networked learning objectives, or coping with basic networked learning demands. As shown, there are grounds for accepting that these respective concerns directly influenced many aspects of how individuals undertook and experienced networked learning, and where there was little direct evidence of this influence in particular behaviours or feelings, there was arguably some common bond with other behaviours that were more obviously affected by one of the three underlying concerns.

The coping, achieving and understanding orientations can themselves be seen to reflect increasingly sophisticated attitudes towards undertaking networked learning, as there seems to be a natural progression from trying to satisfy the most basic requirements of participating in a networked course of study, to then purposively focusing on learning what is interpreted as most important to satisfying the formal objectives, and lastly to transcending instructional parameters to develop a rich domain knowledge. It is also clear that the traits associated with each particular aspect of networked learning, regardless of whether they directly reflect these concerns, follow a similar pattern. For example a minimal-through-selective-to-full breadth of reading, or requiring structure, guidance or being self-governing in the ability to study autonomously online.

Subsequently it is through recognising this pattern within each set of traits, and the relationships across them, that specific traits can be brought together in identifying and describing the three approaches to networked learning alluded to. The approaches and their defining traits are summarised in Table 01, which depicts the outcome space for the preceding analysis. As with the outcome space of any phenomenographic analysis, this is a classification scheme reflecting the limited number of ways of experiencing a social phenomena, and in which a natural order is assumed. Although attributing descriptive terms to the approaches identified is a somewhat arbitrary act, in considering the collective nature of the related traits the eventual distinction was between a constructive-autonomous, active-autonomous, and passive-autonomous approach to networked learning. The 'autonomous' suffix refers to the main characteristic of the networked learning the students engaged in, whilst the constructive, active, and passive prefixes are felt to reflect the general manner in which this was undertaken.

TABLE 01: APPROACHES TO NETWORKED LEARNING AND ASSOCIATED TRAITS

Constructive-Autonomous	**Defining Traits**
General characteristic: Full engagement in experience of autonomous networked learning	Concerned with developing understanding Fully pro-active interaction with NLE and features Effective time-management and self-motivation Sources knowledge from outside NLE Preference for networked instruction Confident in ability to learn autonomously via NLEs
Active-Autonomous	**Defining Traits**
General characteristic: Responds to main demands of autonomous networked learning	Concerned with assessment achievement Purposeful selective interaction with NLE and features Effective time-management and self-motivation Partial preference for lecture-based instruction Requires regular 'seminar' guidance to learn via NLEs
Passive-Autonomous	**Defining Traits**
General characteristic: 'Just-in-time' learning	Concerned with coping Minimal-required interaction with NLE and features Poor time-management and self-motivation Leaves difficulty unresolved Preference for lecture-based instruction Requires structure of traditional courses to learn

If there is natural order to be found in the way students undertook networked learning, then it is the constructive-autonomous approach that theoretically represents the high end of the continuum. That is because, in being considered constructive, any individual taking this approach is essentially interacting with their environment as pro-actively as possible, with an interest in knowledge, and for all intents and purposes is the type of student whose attitude and behaviour would seem ideally suited to realising the benefits of networked learning espoused in the contemporary constructivist literature. In this respect they are hypothetically the 'ideal' networked learner, arguably the sort assumed to be interacting with educational environments in much of the theoretical literature.

The constructive-autonomous approach is conceptualised as being characterised by full immersion in the experience of autonomous networked learning. The dominant concern is with developing as complete an understanding of the subject area as possible. Typically this would include focusing on appropriating knowledge of concepts and theories, and reading across the entire breadth of the subject material. In doing so they will probably address domain basics first. When encountering supportive visual multimedia they study every graphic or model they are presented with, and only proceed when satisfied they have grasped the concept or process depicted. They are likely to participate reflectively in asynchronous discussion by taking time to contemplate the views expressed, and before expressing their own they will undertake extensive research, where this is felt to be appropriate, to ensure that their opinions are well-informed. The constructive-autonomous learner manages their time very effectively, which is a necessity for such pro-active interaction with their environment, and as such a high-degree of self-motivation can be implied. In seeking to understand the mediated subject area to the best of their ability, they are also the kind of student most likely to seek knowledge from print or online sources out with the environment either as a matter of course, or in attempting to resolve any misunderstanding they cannot reconcile within the environment itself. Similarly they will also follow most or all of the external web links they are provided with. When first interacting with a networked environment they orientate themselves towards the learning to be undertaken by taking an overview of the subject area from the mediated material. The rationale is to provide a broad perspective for informing and guiding subsequent knowledge appropriation. Finally, on an affective dimension, constructive-autonomous learners feel confident in their own abilities to work independently and in relative isolation, appreciate the opportunities networked learning offers, and would prefer it as the main method of course delivery.

Whereas a constructive-autonomous learner responds to all the challenges of networked learning, an active-autonomous learner responds to the main demands of the experience. In part this is due to their concern with the formal requirements of the course, typically with a view to assessment achievement. This explains why in initially orientating themselves towards learning they read course outlines and assignment specifications to the exclusion of the subject material. When they do read subject material they do so selectively, opting to look at the sections of material they consider important to the assessed work and also maintaining this focus during the act of reading. As such they can be expected to follow only those external links that may lead to useful assignment-related information, and only source material from out with the environment if deemed necessary for this purpose. In interacting with supportive multimedia they will purposively study graphics and so on, but only when they relate to some aspect of the subject they are either unable to grasp from the text alone, or about which they have limited previous knowledge. During asynchronous discussion they pay particular attention to any messages that may contain useful information for or about assessed work. As maximising understanding of the subject area is not their main interest they are likely to be less active participants in discussion than constructive-autonomous learners, and more likely to research and reflect on the content of their own contributions if this is being assessed. Being focused on the formal components of their course may contribute to their preference for hybrid instruction that combines lectures and networked learning, as ultimately they consider the lecturer to hold the 'official' viewpoint against which their own is to be judged, and view the provision of online material as an opportunity to optimise what they learn or record during lectures. This partial preference for lectures is also associated with the active-autonomous student feeling a need for regular interpersonal tutor guidance during networked learning. Like the constructive-autonomous approach, time-management and self-motivation are good.

This cannot be said of the passive-autonomous approach, which is characterised by a 'just-in-time' undertaking of, and attitude towards, networked learning. The passive-autonomous learner is primarily concerned with doing only what is necessary to cope with a networked course. They tend to read for rote memorisation by focusing on facts and terminology within the subject material, usually when cramming immediately prior to formal deadlines, and show no obvious motive towards maximising understanding or achievement. They are unlikely to read all the mediated material, and will proceed no further than initial sections of content or otherwise skim read a small amount throughout. This minimal interaction with core material extends to all aspects of their engagement with the environment. Thus they will tend to utilise only a selection of the multimedia elements presented, but select from them non-purposively and look at rather than actually study their content. They will generally only participate in online discussion if they are being monitored or assessed for doing so, and even then is the type of student least likely to reflect on the contributions of themselves or others. External links are very rarely followed, or any material from out with the environment sourced. The first time they read any course material is when they begin studying, and if re-reading fails any difficulty in understanding is left unresolved. Both these traits are indicative of the poor time-management associated with this approach, which is generally described as being 'just-in-time' because passive-autonomous students typically only ever begin any form or networked learning activity at the point when imminent deadlines dictate they have to [9]. Regulating their learning by deadlines

[9] This literal form of 'just-in-time' learning is to be distinguished from that normally spoken about in relation to networked learning, which advocates students acquiring new knowledge and skills as they are required in order that

conveys their poor self-motivational ability, which is also reflected in their preference for traditional lecture-based instruction as the perceived need to be seen attending lectures, coupled with their temporal restrictions on the delivery of material, ensures some consistent exposure to course content. The passive-autonomous learner also relies on direct instruction in the presence of the tutor in order to know exactly what they are expected to learn and by when, and struggles with assuming the responsibility for their own learning required in autonomous networked contexts. If they value networked learning, it likely to be as a fail-safe to poor conventional studying habits.

Prior to considering the application of the classification scheme, a number of points concerning the conceptualisation of the approaches require acknowledging. First, although they are taken to represent a continuum of increasingly sophisticated networked learning behaviour, the active-autonomous approach is more appropriately viewed as closer in nature to the constructive-autonomous approach rather than as a mid-point on the hierarchy. The grounds for this assumption are that both the active and constructive approaches reflect some sense of how to learn effectively that, unlike the passive approach, has actually been put into practice. The second point is on the distinction between the non/minimal-required and selective forms of interaction respectively associated with the passive and active approaches. Where as a passive learner will simply not use a feature of the environment without any conscious decision on their part, or will use it as minimally required by the demands of a particular task, an active learner will not use a specific feature after consciously deciding it is unimportant to their learning. Related to this, it might be questioned whether the active-autonomous learner is interacting with their environment selectively purely based on what they interpret as the formal learning objectives, or to maximise the amount of time they can

learning is more meaningful (Goodyear & Steeples, 1992; Romiszowski, 1997b). Clearly the 'just-in-time' character of the passive-autonomous approach greatly reduces the opportunity for meaningful learning.

spend on that which they don't understand. An individual tailoring their learning to their own knowledge needs in this way is theoretically exhibiting very constructivist tendencies. Lest this seems to question the boundaries between the active and constructive approaches identified, it is assumed that if the active learner is tailoring their learning in such a way it is within the context of striving to satisfy the formal course requirements. As for the constructive learner who focuses on understanding, interacts fully with their environment, and only proceeds when satisfied of completely grasping the current topic, they are assumed to be responding to their own knowledge requirements in the more quintessentially constructivist manner. Finally it should be stated that although the classification scheme is conceptualised as a hierarchy of networked learning approaches, they are not viewed as entirely mutually exclusive. As indicated below, this is inconsistent with a key phenomenographic belief.

With these points in mind, it is now possible to address how the original accounts of experience were revisited to determine the approaches taken by individual students, and in doing so establish both the descriptive value of the classification scheme, and how the respective approach types influenced networked learning effectiveness [10].

[10] Although coincidental, a certain similarity between the approach classification names used in this research and that used by Linn (1996) should be acknowledged. In the context of distance learning, Linn differentiates between autonomous, active and passive learners. Broadly, autonomous learners are defined as assuming full responsibility for their own learning, active learners as following course instructions, and passive learners as expecting to absorb information whilst under direct instruction. This basic distinction is not original, as established phenomenographic research attests to, although Linn's terminology is somewhat echoed in that of this study.

5.2.2 APPLICATION OF THE PHENOMENOGRAPHIC OUTCOME SPACE

In phenomenography the point of returning to the individual as the unit of analysis is to establish, through application of the outcome space, which hierarchical classification accurately describes how they experienced the phenomena in question. Because an outcome space is based on a conceptualisation of the likely relationships between thematic categories of description, which are themselves derived from an analysis of collective experience, it is not expected that every individual will match perfectly a specific classification but instead most resemble one over others (Marton, 1994; 1998).

A thorough re-reading of each individual account of the networked learning experience was typically sufficient to reveal the dominant approach taken, as in most cases the description provided was heavily suggestive of a student possessing the majority of traits associated with a particular approach. However the classification process was not simply a quantification of how many related traits were exhibited. As with the thematic stage of the analysis, the emphasis was on the core qualitative meanings in the descriptions. This meant that it was possible to make an informed decision about the approach taken by individuals who, for example, were interacting with an NLE that lacked multimedia and an asynchronous discussion facility. It also helped in those rare cases where an account had to be re-read in order to identify the probable approach taken. Although the dominant approach of the majority was easily discernable, the active-autonomous approach had the most intra-classification variation. Although conceptualised as being closer in nature to the constructive-autonomous approach, in applying the outcome space it was clear that a small number of active-autonomous learners veered slightly more towards a passive-autonomous position [11].

[11] This issue is addressed when critiquing the descriptive validity of the classification scheme identified.

TABLE 02: NETWORKED LEARNING APPROACH CLASSIFICATION FREQUENCIES

	CASE STUDY 1	CASE STUDY 2	EXPERIMENT	APPROACH N/%
C-A APPROACH	3 30.0%	3 18.8%	5 25.0%	**11** **23.9%**
A-A APPROACH	5 50.0%	7 43.8%	7 35.0%	**19** **41.3%**
P-A APPROACH	2 20.0%	6 37.5%	8 40.0%	**16** **34.8%**
TOTAL N CONTEXT TOTAL % CONTEXT	**10** **100.0%**	**16** **100.0%**	**20** **100.0%**	**46** **100.0%**

Table 02 presents the approach classification frequencies within each research context, and overall. Of the forty-six students involved in the investigation, eleven (23.9%) were categorised as having taken a constructive-autonomous approach, nineteen (41.3%) an active-autonomous approach, and sixteen (34.8%) a passive-autonomous approach. There were slight variations on this general pattern across research contexts, but given the small numbers involved at this level there is little to note except perhaps that only two students on the human factors module were classified as passive-autonomous, and otherwise constructive-autonomous learners were always the minority.

5.2.3 INDIVIDUAL APPROACHES AND INTERACTION WITH NLEs

A consideration of some individual accounts of undertaking networked learning may help in illustrating how descriptively accurate the classification scheme of approaches was in relation to the original data, in addition to exemplifying the different approaches in practice rather than theory. As a complete examination of any individual accounts is impractical, the examples given provide fuller summaries of the approaches taken by select individuals whose behaviour was touched upon in the preceding analysis.

HF10 was found to have taken a constructive-autonomous approach to the human factors module. On first accessing the NLE they read over all the course material to get an overview of the subject area. When studying they read the material "thoroughly", noting anything they didn't understand and explaining that sometimes "I'll even write it down, write it out and think 'Well, what do they mean?'". They stated that "if from that one source it's not clear I'll look at another book on the matter, or a journal article or something", and this quest for understanding lead them out with the human factors environment. They reported sourcing relevant print materials, and using the web to find online materials. They "went through all the [external] links", often finding that "you could use that other link as an information resource, as a good way to find other sources of relevant information". In participating in the problem solving assignment via the asynchronous discussion facility they carefully researched and composed their own messages, and read in full all of those from their colleagues. Of their time-management and study skills they explained that "I've always been disciplined about trying to organise my work", and in relation to studying online that "leaving it to the last minute's not the way I work. I'm just organised". They felt very comfortable with networked learning, and welcomed the increased control of their learning this offered.

In the context of the experimental study, the attitudes and behaviours of the student EX14 were also considered constructive-autonomous in approach. Their main focus in reading the mediated material was also to understand the subject as completely as possible, which extended to their interaction with supportive visual multimedia. They were conscious of having purposively studied the graphics and animations "whenever there was one", and described "trying to understand the point or, you know, the process. And then when I felt I'd gotten it move on to the next part". This student was interacting with a version of the experimental NLE that did not feature a discussion facility, but explained "the lack of student contact I wouldn't say was a huge problem…I do work well alone anyway". Their comfort with working independently also extended to working in relative isolation from the tutor, and they indicated their ease with computer-mediated tutorial support in stating "I had e-mail so I didn't feel like I was missing out on anything there…It's the way I normally contact tutors anyway". They were also organised, setting themselves a routine for regulating their networked studying in that they "tended to do it twice a week, usually at the beginning of the week when I would read it and do my activity, and then at the end of the week for a shorter time before the test for the next week". Ultimately they believed of autonomous networked learning "It's a way I like to work and I'm good at doing it".

Evidence of the active-autonomous approach was seen in the account of CC10, one of the chemistry students. They had clearly focused on what they thought was required in order to do well in their exam, stating that when reading "I would never try and learn a full chapter but I would try and learn the main bits out of the chapter, so that's what I did with the [web-based] module". The parts of the material that they did decide to study were based upon "looking at the past paper questions to see what sort of things came up", and what they saw as the gap areas in their lecture notes. As they explained of their general rationale when interacting with the chemistry NLE "there's no point in learning something that is beyond where I need to go…The whole point is that I feel I've got to pass the exam". Interaction with constituent elements was similarly selective, and whilst they explained "I have this problem about seeing things in 3-D…so I found it quite useful to look at the Chime Models because you could spin them around", they conceded to only studying the visual multimedia relating to the topics they chose to concentrate on. Although they understood the purpose of the discussion facility provided, as at the outset they read the introductory section explaining the features of the NLE, they never tried to use it because "I just didn't think it was important…I was there for the information, not to talk to people about it". They also decided not to use the external links, believing "there was enough information in the web site itself…that there wasn't any need for further reading". Although interacting selectively with the environment they did study consistently, explaining that "the only reason I would say 'Right, I'll try next week' was if I could never get in the computer lab". They saw self-paced learning as a major advantage of networked learning, but their concern with formal learning objectives meant they would have liked concurrent lectures as "web-based it gives you an overview of what the content is, but they point you in the right direction in lectures about what might come up in the exams".

Similarly to the above individual, the student HF09 also enjoyed networked learning "because you can do everything at your own time and when you want to do it", and mirrored many of the same active-autonomous traits in relation to the human factors module. They too relied on the core subject materials in the main, only making use of external links when they would help with completing one of thee assignments. They explained that "how I go about reading is to see if it is relevant to me and my assignment. That's the only reason I would read it and then use it if it is relevant". In using the asynchronous discussion facility featured in their environment they saw the opportunity to reflect as an advantage, and indicated "I did tend to think about what I wanted to say, probably more so than I would in a face-to-face discussion". At the same time, they intimated that this was mainly because they were being assessed for their contributions and wanted to do as well as possible. As expected of an active-autonomous learner, they had managed their time effectively. However in studying autonomously they sometimes felt ill-at-ease in not having face-to-face contact with the tutor. This was concerned with a need for guidance in attaining the formal learning requirements: "You can tell by the tone in the lecturer's voice, the gestures that they have, and also they can say to you 'this is very important, you must learn this point". Although mainly positive towards networked learning, they felt "I need the face-to-face contact with lecturers. That's what I'm used to and I don't think that will ever change".

Regarding how the passive-autonomous approach manifested itself in practice, the student EX13 had no apparent strategy for learning what was covered in their version of the experimental NLE other than "just reading through it just before the tests, and trying to remember what I could". They described reading the Outline section to find out what the first practical activity entailed, but then not returning to it. This may account for them stating that "I did the first one, but I don't think I did any of the others. I think I just forgot about them". Essentially this student was reading minimal amounts of the core material, and only then when one of the periodic knowledge tests was imminent. A link with poor self-motivating ability was evident in them explaining "I kept on thinking 'Oh, I'll do it later', and then I didn't do it for very long. You don't really look at it unless you have to. At least, I didn't. Then I thought 'I'd better look at it because I've got that test tomorrow'". Interaction with supportive multimedia was minimal, and although they "looked at a few" of the visuals, the emphasis was on passive viewing rather than purposeful studying. As they described in relation to the animations, "I just usually played them once to see what they did", but they "didn't look at all the ones in the second section because I didn't look through all of it". They did not feel suited to networked learning, and would have been more motivated to attend lectures because "you know you've got to be seen at a few of them". Working in isolation from peers was problematic as they often monitor their own progress against that of others. On requiring regular tutor intervention, they believed "if someone told me 'You have to do it now!' that would have made me look at the web site more...I need that incentive".

Finally, and also exhibiting a passive-autonomous approach, the student CC15 compared reading the subject material in the chemistry environment to "flicking through a book but just reading a few lines...and you just sort of move on". They explained trying to pick out and memorise key formulae and terms, but their breadth of reading was limited "more to the carbohydrate part, like the very beginning of it, because I never really got as far through". Their interaction with other constituent elements was also minimal, and in relation to coming across the online assessments stated that "I clicked on one or two of them, but I never actually tried to seriously use them". Although they indicated having a cursory look at some of the Chime models and interactive diagrams, they never followed any of the external links. As for the discussion facility they "didn't check it once", and showed the lack of cogency associated with a passive-autonomous approach in admitting "I don't know why". This student was unhappy about the prospect of an entirely web-based module, although they stated that "it would depend if the lecturer was there with you as well...if they were in the same room helping you along and you could ask questions that would help, but I would still need tutorials". Having the tutor present during what the student indicated would ideally be class-based workshops inferred their reliance on the structured activities of traditional lecture-based courses. As they stated "even if I had read it [the web site] in more detail I probably wouldn't have understood it better...I'd rather have somebody tell me and show me than actually try and learn myself".

5.2.4 INDIVIDUAL APPROACHES AND REALISATION OF AFFORDANCES

If the approaches identified provide a plausible description of the different ways students in this investigation undertook networked learning, then a link between individual approach and networked learning effectiveness might be assumed. In the context of this research, this can be judged on two levels. The most obvious is in terms of assessed outcomes. The other is in determining the extent to which taking a constructive, active, or passive-autonomous approach might have influenced the ability of individual students to realise, or gain from, the various 'affordances' thought to be inherent within the properties and technologies of a networked learning environment.

What is immediately apparent in reflecting only broadly upon the different approaches is that theoretically they must be conducive in varying degrees to the realisation of networked learning affordances. The passive-autonomous approach must be the least conducive because the general characteristic of this approach, just-in-time learning, leaves little scope for the type of active, reflective learning necessary to properly benefit from interacting with a NLE. For example instead of being able to progress through the basic course material responding to their own knowledge requirements at their own pace, and thus exploiting the main affordances associated with autonomously-accessible hypertext, the passive-autonomous learner has only the time and inclination to skim-read for rote memorisation. Conversely, the active-autonomous and constructive-autonomous approaches can be reasoned to be more conducive to realising networked learning affordances as they both involve a degree of effectively organised interaction with NLEs, and purposeful engagement with at least some of the available resources. This line of thought suggests that constructive-autonomous learners are, in principle, the most likely of all to benefit from networked learning affordances because they focus on appropriating as full an understanding of the mediated subject area as possible, and in doing so interact pro-actively with all the materials and resources at their disposal.

The proposed distinction in the potential to benefit from affordances between a passive approach on one hand, and the active and constructive approaches on the other, seems to hold true in practice. Much of the preceding data provides implicit examples, with those describing active and constructive traits often referring to the benefits they experienced, and the distinction becomes explicit when directly contrasting individual comments pertaining to the major affordances of networked learning. So as regards the opportunity for self-paced learning, it was active or constructive-autonomous students who most frequently commented: "You to take it in better because you're learning when you want to want to…I think because of that web-based learning probably helped me learn more than if I was just in lectures" (CC16). They were also most forthcoming with evidence of learning having been enhanced through visual multimedia, such as the constructive-autonomous learner who described a cognitive offloading effect in stating: "with the interactive diagrams you could see things taking place rather than just writing out a normal chemical reaction…So instead of having to work it out yourself there's a more immediate understanding of the reaction, and you can concentrate on really learning what you're being shown" (CC01). Lastly, active and especially constructive-autonomous learners were more likely to cite particular instances when they exploited the reflective potential of asynchronous discussion, such as the constructive-autonomous human factors student who recalled that "It was very useful to look at what other people had said and take it away with you, and then sit and construct your reply…We were designing an IT room, and I provided drawings by sending them in as files. And I could explain what I was trying to say better with these drawings" (HF01).

By comparison those who exhibited a passive-autonomous approach were far less consistent in describing how their NLEs had aided their learning. That is not to say they never experienced any of the potential benefits, as occasionally they did. However in relation to the opportunities of self-paced studying, learning from supportive multimedia, and participating in asynchronous discussion respectively, more typical comments included: “It’s useful if you’re wanting to spend more time on something you find difficult, although I sort of read it all at the last minute” (EX12), “I don’t remember using any of the interactive diagrams…so they were of no help to me personally” (CC08), and “even though we were to discuss somebody else’s examples, I just picked a couple and mentioned what I thought. I didn't really go into great detail” (EX07).

The disparity between the passive versus the active or constructive learners in their success at exploiting the affordances of their NLEs could be down to passive learners being more naive about what the benefits of networked learning may be. Certainly those who approached it passively were generally negative towards networked learning because of how it differed from traditional instruction, and did not seem to be aware of what it offered them that traditional courses do not. At least in the majority of cases this applied, although it only partially explains the disparity as it became evident during analysis that some passive-autonomous learners were aware not only of some of the potential benefits, but also that their particular approach had indeed limited their own potential for acting upon them. Table 03 illustrates how taking a constructive or active versus a passive approach influenced the realisation of networked learning affordances.

TABLE 03: INDIVIDUAL APPROACHES AND THE REALISATION OF NL AFFORDANCES

Self-Paced and Active Learning of Domain
"I used it at least once a week. I'd normally work through one section at a time...It was obviously good that you could decide when you wanted to learn. Sometimes in a lecture you're tired, or your notes are bad. So I think it's good that you can look at it when you feel like it, and you know you're going to take it in because you actually want to learn at that point so you do tend to learn better. I enjoyed the learning more because I was doing it at my own pace, and because of that I did learn more from using the internet than I did from the lectures that we got for carbohydrates" (CC13, Active-Autonomous). "It's good having all the information there for you in advance. You can look at it when you want to and you can work at your own speed... I don't know if it worked for me. It would maybe work with other people, but you have to sort of really push yourself. I'm just not like that...I left it all to the last minute. I could have done better if I had looked at it more. I would be too tempted to do other things once I'd got the computer switched on, because I'm quite bad that way. A lot of things I missed out and could have read further to be able to answer the questions better" (EX19, Passive-Autonomous).
Supportive Visual Multimedia and Cognition
"If I came to one [graphic] then I'd basically study it until I could see what it was about, and if I was to change anything, or push play or whatever, then I'd do all that a few times...It helped stay in my mind better than if it had just been just words. When I remembered a graphic then I'd remember the idea behind it, and why it was there...In some of them [the periodic knowledge tests] I remembered seeing the pictures and that kind of made me remember why the picture was there in the first place and I remembered the words behind it. So it jolted my memory into working" (EX11, Constructive-Autonomous). "I did use the web site, but it was hard to make myself use it. I didn't really make the time to do it all properly...I didn't really work with any of them [Chime Models]. But it was good that you could actually do that, you know, and if you did then it would have been good being able to see it in the 3-D and being able to rotate it and that...Sometimes you can't picture it in your head in 3-D, but on the screen you could move it round to see the back and the front and all the rest of it. And then you could have seen it, you know, actually seen it in your head. That would have been good" (CC11, Passive-Autonomous).
Reflective Participation in Asynchronous Discussion
"The good aspect of not having face-to-face contact is that I had time to explore and decide what I was going to say, and make sure what I said was different to what other people said, that I contributed something different to the discussion group...You're reading what other people said and responding to it, but you've got your own time to do that as opposed to having a seminar class where if you didn't think of something at the time then you could go to them later and say it, but that's not really going to happen...I took time to compose it so I made sure I said everything that I wanted to" (EX06, Active-Autonomous). "It [online discussion] is a bit better because at least you can word it right and take time to think about what you're actually going to say so that it doesn't come across wrong...Well I couldn't say I was really thinking about what I wanted to say, because I'd only send my stuff in when I needed to. Like on the day I had to...If I'd had a message about meeting up I'd go 'OK. See you then', which I didn't have to think about. But when you're actually putting your opinions across it's different. That's when you should spend more time thinking about what you want to say, although I didn't really" (HF05, Passive-Autonomous).

In each of these examples the passive learner shares with the active or constructive learner an awareness of how self-paced learning, supportive multimedia, or asynchronous discussion with peers could contribute to their understanding. The difference is that only the active or constructive learners used their environment in a manner appropriate to this. So whilst the active-autonomous learner describes being organised and consistent in studying the mediated material, which they felt resulted in increased understanding, their passive-autonomous opposite understood the implications of autonomous studying but conceded "I don't know if it worked for me...I left it all to the last minute" (EX19). Similarly whilst the constructive learner has purposively studied the supportive multimedia and has had their comprehension and recall ability enhanced by the dual-coding potential of contiguously presented pictures and text, the passive learner alludes to the cognitive offloading, or visualisation, effect they might have experienced had they properly studied the Chime Models in the chemistry environment. Finally the active learner indicates reflecting on the opinions of their peers and themselves before communicating their thoughts in asynchronous discussion, and the passive learner admits that's what they should have done.

In addition to providing further evidence for the passive-autonomous approach being the least conducive to the realisation of networked learning affordances, these findings also suggest, contrary to much of the constructivist literature, that it is misleading to assume that the affordances inherent in the properties of a NLE are opportunities for enhanced learning that will benefit one and all. Clearly they did not always benefit passive-autonomous learners due to the nature of their approach, and through selective interaction it can be assumed some potential affordances went unrealised by active-autonomous learners. Instead the indication is that the potential to benefit from the educational properties of a networked learning environment is dependent upon the motives and behaviour of the learner in question. This is closer to the original concept of an affordance being an emergent relationship between the needs of an individual and the opportunities for action that is presented by an object in their environment [12].

---

[12] Chapters 7 and 8 discusses the need to re-define the concept as it is currently applied to educational technology.

5.3 NETWORKED LEARNING APPROACHES AND OUTCOMES

Given the nature of the approach types identified, and their apparent influence on the extent to which individuals benefited from the educational properties of their NLEs, then some impact on formally assessed learning outcomes might be expected. The data provides some evidence of a link between approach classification and achievement.

5.3.1 CASE STUDY 1

Determining achievement by approach for the human factors students was problematic as final grades for their coursework was determined through an accumulation of individual marks, group marks, and peer assessment. It was therefore decided to take into account individual marks only. These the students received for quality of contributions to the asynchronous discussion-based problem solving assignment, and for their individual human factors key issues report. The grade and combined grade averages for these assignments by approach classification are shown in Table 04.

TABLE 04: NL APPROACH x MEAN INDIVIDUAL ASSIGNMENT MARKS - CASE STUDY 1

	PROBLEM SOLVING	KEY ISSUES REPORT	APPROACH MEAN
C-A APPROACH (N 3)	67.3%	65.3%	**66.3%**
A-A APPROACH (N 5)	60.8%	55.6%	**58.2%**
P-A APPROACH (N 2)	55.0%	58.5%	**56.8%**
ASSIGNMENT MEAN	61.0%	59.8%	60.4%

On the problem solving exercise those who took a constructive-autonomous approach had the highest mean grade at 67.3%, followed by active-autonomous learners at 60.8%, and passive-autonomous learners at 55.0%. Essentially this is the pattern that might be expected if the passive-active-constructive classifications do generally reflect increasingly sophisticated and purposeful ways of approaching networked learning [13]. However on the key issues report the mean grade for the active-autonomous learners was considerably lower than that for the passive-autonomous learners. One of the passive learners scored higher than any active learner on this assignment, and because there were only two passive learners on this module this could explain the departure from the expected pattern, if not why this student did so well. Overall through, the combined mean scores for approach indicate that constructive learners were the highest achievers, followed by the active then passive learners. Only the constructive learners were above the mean for either assignment, and by a margin of around six percent.

5.3.2 CASE STUDY 2

The carbohydrate chemistry students were assessed via an end of term exam in which they were to answer four questions from a choice of eight. Four questions were on topics covered in the carbohydrates half of the module, and students could answer any mix of questions including only those relating to one half of the module. From the information made available to the researcher it is known that all those involved in the investigation attempted at least one carbohydrates question. Determining an exact number for each student required access to exam manuscripts, which was not possible.

---

[13] The assessment criteria employed by the tutors on the case study modules is assumed to have been robust.

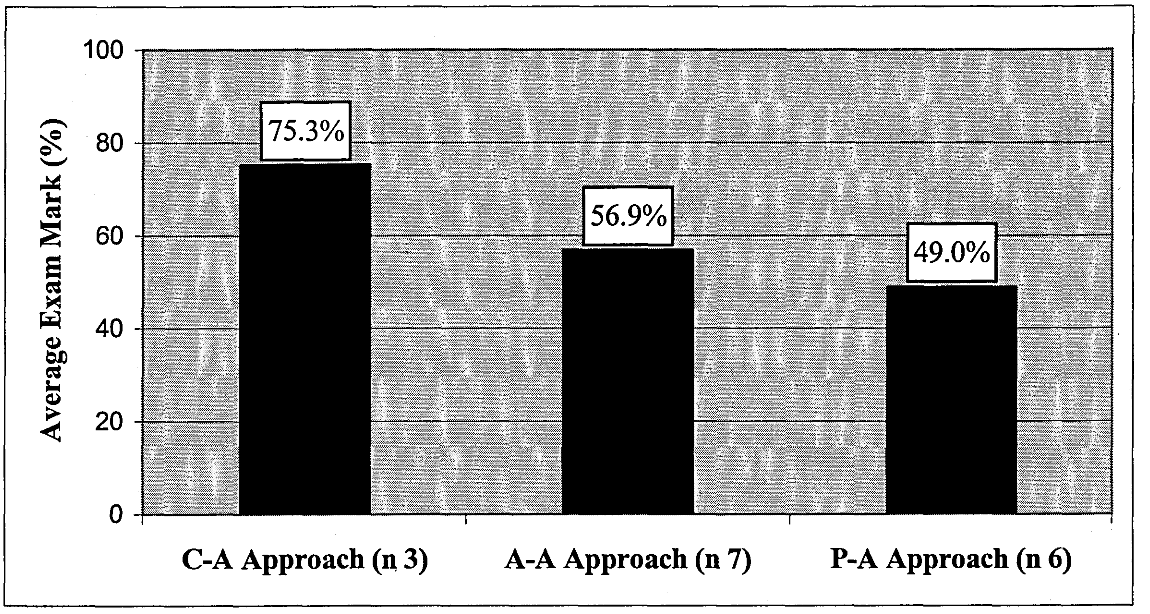


FIGURE 01: NL APPROACH x CARBOHDRATE CHEMISTRY EXAM GRADE

Although for this reason the mean exam grades by approach (Figure 01) must be treated as a tentative indication of networked learning achievement, and more so given that the students received lectures as well, it can again be noted that the three students who had taken a constructive-autonomous approach were by far the highest achievers with a 75.3% mean grade. They were followed by the seven active-autonomous learners at 56.9%, and the six passive-autonomous learners at 49.0%. The margin between the active and passive learners becomes greater if discounting the 94.0% grade of the learner CRCV. During analysis this student stood out for having taken a clearly passive approach to networked learning in that they skim-read the material, interacted only minimally with constituent elements, and expressed a dislike for studying this way and having to assume responsibility for their own learning. However they distinguished themselves from the other passive networked learners in indicating that they attended all lectures, followed up on the textbook readings, and aside from using the NLE fairly basically, studied consistently throughout the module. Generally, the passive learners alluded to having poor conventional studying habits. If this student is treated as an exception, the mean passive approach grade then becomes 40%. Regardless, and although an indirect measure, the data does still indicate an approach-achievement link.

5.3.3 EXPERIMENTAL STUDY

In the experimental study, the periodic knowledge tests had two parts. The first consisted of three short-form questions to assess any conceptual knowledge gained from studying particular sections of the mediated material, and this was followed by a ten-item multiple choice test to assess any factual knowledge gained. They were completed in this order to ensure the multiple choice tests could not be referenced when providing the written answers. Due to the conditions of the experiment described in chapter 3, the test results can be taken as a direct indication of networked learning achievement.

The answers to the written tests were analysed using the SOLO taxonomy (Biggs & Collis, 1984). This instrument allows verbal, typically written, learning outcomes to be categorised according to the conceptual complexity evident within them. There five levels within the taxonomy: prestructural, unistructural, multistructural, relational, and extended abstract. Respectively these represent no meaningful response, identification of one relevant issue, identification of several relevant issues, identification and forging of links between several or all relevant issues, and forming a hypothesis. There were no responses at the extended abstract level, which probably reflects the parameters of the experiment as learners were restricted to using the necessarily basic materials provided.

TABLE 05: NL APPROACH x WRITTEN TESTS SOLO OUTCOMES – EXPERIMENT

	SOLO 1	SOLO 2	SOLO 3	SOLO 4	APPROACH N/%
C-A APPROACH (N 5)	5 2.8%	6 3.3%	21 11.7%	13 7.2%	45 25.0%
A-A APPROACH (N 7)	7 3.9%	13 7.2%	38 21.1%	5 2.8%	63 35.0%
P-A APPROACH (N 8)	12 6.7%	32 17.8%	28 15.6%	0 0.0%	72 40.0%
TOTAL N ANSWERS TOTAL % ANSWERS	24 13.3%	51 28.3%	87 48.3%	18 10.0%	180 100.0%
SOLO 1 = Prestructural response; **2** = Unistructural; **3** = Multistructural; **4** = Relational response.					

Of the one hundred and eighty answers completed over the three written tests (nine from each of the twenty learners), a majority of 48.3% were at a multistructural level. This indicates that whilst most of the answers provided correctly identified several issues pertinent to the questions asked, the interrelationships between issues were not fully known. In fact only 10.0% of answers were at relational level of conceptual understanding. However of this proportion, 7.2% of relational answers had originated from five constructive-autonomous learners, with the other 2.8% coming from seven active-autonomous learners. Given the confidence with which these findings can be attributed to networked learning effort, it is evident that the focus constructive learners placed on developing as full an understanding as possible did result in qualitatively better knowledge. The active-autonomous learners were the group who provided most answers at the multistructural level, followed by the passive-autonomous learners. If this suggests a pattern of diminishing returns based on approach, then it is confirmed by the passive learners providing the most answers at a unistructural level, signifying an answer demonstrating knowledge of one relevant issue, and also the most answers at a prestructural level that translates to either no, or no meaningful, response.

TABLE 06: NL APPROACH x MEAN M/CHOICE TESTS MARKS – EXPERIMENT

	TEST 1	TEST 2	TEST 3	APPROACH MEAN
C-A APPROACH (N 5)	7.8/10	7.6/10	8.6/10	**8.0/10**
A-A APPROACH (N 7)	5.0/10	4.9/10	7.6/10	**5.8/10**
P-A APPROACH (N 8)	5.8/10	5.9/10	6.5/10	**6.0/10**
M/CHOICE TEST MEAN	6.2/10	6.1/10	7.6/10	6.6/10

As Table 06 shows, the results on the multiple-choice tests tell a slightly different story. Constructive-autonomous learners still dominate with an 8.0/10 approach mean score, had the best mean scores on each test, and were the only group to exceed the 6.6/10 overall mean for the tests. However the passive-autonomous learners performed marginally better than the active-autonomous learners, with a 6.0/10 to 5.8/10 overall mean score, and judging by the means for each test had also been the more consistent achievers. One possible explanation for this is that the passive approach learners focused exclusively on rote memorisation of facts and terms when reading the core subject material, which they tended to do immediately prior to the tests. Research into how students approach learning on conventional courses has shown that this type of behaviour, associated with a surface approach to studying, can result in temporarily high levels of factual knowledge. Otherwise good factual knowledge is thought to be a by-product of developing a sound conceptual understanding (Marton et al, 1997). The tendency of the active-autonomous learners was to learn only what they perceived as being important. Perhaps in not always reading for understanding, and limiting their reading to certain content, they were least effective at acquiring factual knowledge.

5.3.4 QUALITY OF CONTRIBUTIONS TO ASYNCHRONOUS DISCUSSION

Although not an assessment of achievement, it was felt an additional insight into how the constructive, active and passive learners applied themselves could be gained from a simple content analysis of their asynchronous discussion contributions. The five classifications in the scheme developed were: opinion stated (OS); opinion stated and explained (OE); opinion referenced (OR); opinion referenced and elaborated (ORE); and document posted (DP). These were used to categorise postings in which: an opinion was given without explanation; an opinion was stated and explained; an explanation was justified with reference to the mediated course material or relevant online or print source; an explanation considered the implications of the referenced findings to the issue being discussed; and where a document URL, attachment or text extract was posted on-line without any explanation of pertinence to the issue being discussed. This last classification was to account for students on the human factors module distributing relevant reference material to members of their assignment group.

Non-subject related messages, taken to include those of a short confirmatory nature (i.e. yes/no replies) or that dealt with administrative issues, were excluded from the analysis.

TABLE 07: NL APPROACH x QUALITY OF ONLINE DISCUSSION – CASE STUDY 1

	OS	OE	OR	ORE	DP	APPROACH N/%
C-A APPROACH (N 3)	8 11.3%	5 7.0%	2 2.8%	3 4.2%	8 11.3%	26 36.6%
A-A APPROACH (N 5)	16 22.5%	3 4.2%	2 2.8%	0 0.0%	7 9.9%	28 39.4%
P-A APPROACH (N 2)	8 11.3%	1 1.4%	0 0.0%	0 0.0%	8 11.3%	17 23.9%
TOTAL N MESSAGES TOTAL % MESSAGES	32 45.1%	9 12.7%	4 5.6%	3 4.2%	23 32.4%	71 100.0%

Within the human factors module, a 45.1% majority of messages were simple statements of opinion, with 12.7% including explanation, 5.6% referenced explanation, and just 4.2% elaboration. The distribution of reference material accounted for 32.4% of messages. It is notable is that on only one occasion did either passive-autonomous learner go beyond simply stating their opinion in providing explanation. The active and constructive learners each accounted for two of the four messages including a referenced explanation of opinion, while only the constructive learners elaborated beyond their referenced findings. In fact of the sixteen messages that went beyond a statement of opinion, ten were from constructive learners, five from active learners, with the last one, as indicated, from a passive learner. This pattern corresponds to achievement on the problem solving exercise, which points to a consistency between the researcher and human factors module tutor in their assessments. More importantly, it confirms that within the context of this course constructive learners were indeed the more purposeful and reflective when participating in asynchronous debate, the active learners less so, and that passive learners did no more than minimally required.

TABLE 08: NL APPROACH x QUALITY OF ONLINE DISCUSSION – EXPERIMENT

	OS	OE	OR	ORE	DP	APPROACH N/%
C-A APPROACH (N 2)	3 7.5%	2 5.0%	1 2.5%	0 0.0%	N/A	6 15.0%
A-A APPROACH (N 4)	13 32.5%	8 20.0%	0 0.0%	0 0.0%	N/A	21 52.5%
P-A APPROACH (N 3)	13 32.5%	0 0.0%	0 0.0%	0 0.0%	N/A	13 32.5%
TOTAL N MESSAGES TOTAL % MESSAGES	29 72.5%	10 25.0%	1 2.5%	0 0.0%	N/A	40 100.0%

As previously indicated, the asynchronous discussion facilities that featured within two of the experimental environments were not used as extensively as was intended. Some individuals, all classified as passive-autonomous, did not even participate in online discussion as was minimally required. The scope for inferring from the findings is also limited due to the small numbers of learners of each approach type. As Table 08 illustrates, 72.5% of all messages were statements of opinion. What might otherwise be noted is that the passive-autonomous learners did not go beyond stating their opinions, with only the active and constructive learners providing explanation. Just one message, form a constructive-autonomous learner, contained a referenced explanation of opinion.

Overall, what an examination of the formally assessed outcomes confirms is that across the different networked learning contexts investigated, those who took a constructive-autonomous approach were consistently the highest achievers. This was the reasonable expectation given the conceptualised and observed nature of this approach. The noted exceptions aside, students who took an active-autonomous approach were in the next best position regards learning outcomes. This was also as expected, although it might be questioned why, with their focus on achievement, this group were not closer in their assessed outcomes to the constructive-autonomous learners. Perhaps in relying on their own judgement about what material and features in their environments they should attend to, active-autonomous learners miss much of value. Lastly, the performance of the passive-autonomous learners confirmed their position at the foot of the passive-active-constructive approach hierarchy as they proved themselves to have been least capable in demonstrating a sound understanding of their respective subject areas.

5.4 RELATIONSHIP WITH APPROACHES TO STUDYING

It was anticipated at the outset of this investigation that there might be a relationship between how students undertook conventional lecture-based courses, and how they approached networked learning. This seems a reasonable assumption, and many researchers who claim a link between learning style and student interaction with educational technology have used inventories designed to assess learning style within conventional course contexts. As this research is clearly in the phenomenographic tradition responsible for the 'approaches to studying' conceptualisation of how students learn in higher educational contexts, which is the learning style construct this research has aligned itself with, it was deemed appropriate to try and determine the extent of any relationship between the different approaches to studying and networked learning.

5.4.1 INDIVIDUAL APPROACHES TO CONVENTIONAL COURSES

A short-form version of the latest Approaches to Studying Inventory (Tait et al, 1998a) was administered at the start of the investigation. Students were instructed to complete the inventory providing responses that corresponded with how they felt they generally undertake learning on their conventional undergraduate courses. The ASI measures whether the student takes a deep, strategic or surface approach to studying based on their accumulated scores on series of statements that encapsulate the main traits that are thought to be associated with each approach. The classification of learners at a main scale level, based on the highest approach score achieved, is shown below (Table 09).

TABLE 09: ASI MAIN APPROACH CLASSIFICATION FREQUENCIES

	EXPERIMENT	CASE STUDY 1	CASE STUDY 2	APPROACH N/%
DEEP APPROACH	10 50.0%	4 40.0%	5 31.3%	**19** **40.4%**
STRATEGIC APPROACH	8 40.0%	6 60.0%	6 37.5%	**20** **45.8%**
SURFACE APPROACH	2 10.0%	0 0.0%	5 31.3%	**7** **13.8%**
TOTAL N CONTEXT **TOTAL % CONTEXT**	**20** **100.0%**	**10** **100.0%**	**16** **100.0%**	**46** **100.0%**

Of the forty-six students involved in the investigation, nineteen (40.4%) were classified as taking a deep approach to their conventional courses, twenty (45.8%) a strategic approach, and seven (13.8%) a surface approach. It is not unusual at a main scale level for fewer learners to indicate having a dominant surface approach, as this would essentially mean the learner consistently viewed their motivations and behaviour negatively (Entwistle & Ramsden, 1983). In the respective research contexts, it is notable that none of the students on the human factors module indicated a dominant surface approach, whilst five of the chemistry students did. This again is not entirely surprising, as in domains that necessarily involve learning a considerable body of factual knowledge, for example the physical sciences in which formal terms and formulae need committing to memory, many students rely more heavily than others on the rote learning strategies that they must occasionally employ (Marton et al, 1997).

TABLE 10: ASI MEAN SCORES ON MAIN SCALES AND RELATED SUB-SCALES

	MEAN	ST DEV	RANGE
DEEP APPROACH	**14.2**	**1.9**	**8.3**
Seeking Meaning	14.0	2.4	13.0
Relating Ideas	13.7	2.7	12.0
Use of Evidence	14.8	1.9	8.0
STRATEGIC APPROACH	**14.0**	**2.4**	**8.7**
Organised Studying	13.5	3.0	11.0
Time Management	13.3	3.5	14.0
Alertness to Assessment Demands	15.2	2.1	9.0
SURFACE APPROACH	**11.4**	**1.9**	**8.7**
Lack of Purpose	8.6	2.4	9.0
Unrelated Memorising	11.8	2.3	9.0
Syllabus-boundness	13.8	3.1	14.0
COURSE PREFERENCES	N/A	N/A	N/A
Supporting Understanding	13.4	3.5	12.0
Transmitting Information	17.0	3.3	8.0

The overall mean scores on the deep, strategic and surface approaches and their related sub-scales are given in Table 10, which also provides scores on the stand-alone scales relating to preferred types of course. Within the short-form ASI each sub-scale is measured through four five-point Likert statements with answers ranging from 'strongly agree' to 'strongly disagree'. The minimum possible score for each sub-scale is four, and the highest possible twenty. Scores at the main scale level are therefore based on an accumulated average of the sub-scales pertaining to the traits for that approach.

5.4.2 COMPARISON OF INDIVIDUAL APPROACH CLASSIFICATIONS

From how students described undertaking networked learning, it was apparent that there was often some consistency with how they would normally undertake studying. This was evident in statements like that from the constructive-autonomous learner who explained "I'd read it [the mediated material] trying to understand the concept. That's always the way I always read things, and that way I can bring it into my own experiences" (EX07); or the active-autonomous learner who "tended to concentrate on the bits I thought would be important for our exam. That's how I learn...I look out for those things if I'm reading a textbook as well" (CC04). Similarly, many passive-autonomous approach learners made comments like "I sort of memorised it for the test, then just forgot it again. Just trying to cram. I do that for exams" (EX18).

The methodological rationale for administering the short-form ASI was that if for most students such a relationship exists, then evidence might be forthcoming in comparing networked learning approach classifications with inventory responses. Through cross-tabulating the main scale approaches to studying classifications with those relating to networked learning approach, there is some justification for assuming a link (Table 11).

TABLE 11: ASI x NL APPROACH CLASSIFICATION FREQUENCIES

	C-A APPROACH	A-A APPROACH	P-A APPROACH	ASI N/%
DEEP APPROACH	8 42.1%	5 26.3%	6 31.6%	**19** **100.0%**
STRATEGIC APPROACH	3 15.0%	11 55.0%	6 30.0%	**20** **100.0%**
SURFACE APPROACH	0 10.0%	3 42.9%	4 57.1%	**7** **100.0%**
TOTAL N NL APPROACH TOTAL % NL APPROACH	**11** **23.9%**	**19** **41.3%**	**16** **34.8%**	**46** **100.0%**

As previously acknowledged, the fundamental nature of the respective deep, strategic, and surface approaches to studying lies in the intent of the learner to understand, achieve, or cope with course requirements, and these concerns were also central to whether a student was found to have taken a constructive, active, or passive approach to networked learning. Conceptually then, it could be anticipated that a deep approach to conventional studying would align most closely with a constructive-autonomous approach to networked learning, a strategic with an active-autonomous approach, and a surface with a passive-autonomous approach. There is some degree of evidence for these relationships. Of the nineteen students classified as taking a deep approach, eight were within the group of eleven students who had taken a constructive-autonomous approach, and of the twenty students classified as taking a surface approach, eleven were within the group of nineteen found to have taken an active-autonomous approach to networked learning. Less apparent is the relationship between the surface and passive-autonomous approach classifications. Four students exhibited both approaches, but given the disparity between the total numbers classified as surface and passive-autonomous learners little can be read into this. It is also notable that many of those classified as deep learners were found to have taken active and passive approaches to networked learning. Again this may be partly attributable to a disparity in numbers, but it could also be indicative of problems inherent in analysing approaches to studying at the main scale level. Entwistle & Ramsden (1983) believe this can sometimes be problematic as, for example, simply classifying a learner as exhibiting a deep approach based on their highest accumulated score gives no indication of how strong their strategic approach tendencies are. For this reason, and to account for the disparity in numbers between each set of classifications, an analysis of responses to the ASI at sub-scale level, and based on networked learning approach, was undertaken (Table 12).

From this more detailed and arguably more meaningful analysis, the grounds for assuming a relationship between the conceptually similar approaches to studying and networked learning become stronger. Those who had taken a constructive approach to networked learning scored higher than either the active or passive learners on the deep approach scale and all the related sub-scales.

TABLE 12: ASI MEAN SCORES ON SCALES x NETWORKED LEARNING APPROACH

	C-A APPROACH			A-A APPROACH			P-A APPROACH		
	M	SD	R	M	SD	R	M	SD	R
DEEP APPROACH	**15.1**	1.7	6.0	**14.1**	1.9	7.4	**13.6**	1.7	6.3
Seeking Meaning	14.5	2.1	8.0	13.8	2.9	13.0	13.8	2.2	9.0
Relating Ideas	15.2	2.7	10.0	13.7	3.0	10.0	12.6	1.9	9.0
Use of Evidence	15.5	1.6	5.0	14.8	1.8	6.0	14.3	2.2	8.0
STRATEGIC APPROACH	**13.6**	3.1	8.0	**15.1**	1.7	5.7	**12.9**	2.1	7.0
Organised Studying	12.9	4.0	10.0	14.7	2.1	8.0	12.6	2.8	11.0
Time Management	12.5	4.7	13.0	14.6	2.3	8.0	12.2	3.4	10.0
Alertness to Assessment Demands	15.4	1.9	5.0	16.1	2.0	8.0	14.0	2.3	8.0
SURFACE APPROACH	**10.7**	2.0	7.7	**11.0**	2.0	7.0	**12.3**	1.4	4.7
Lack of Purpose	8.3	2.6	9.0	8.1	2.4	10.0	9.4	2.2	9.0
Unrelated Memorising	11.3	2.6	9.0	11.8	2.4	8.0	12.3	2.1	8.0
Syllabus-boundness	12.5	2.6	8.0	13.3	3.4	12.0	15.3	2.4	10.0
COURSE PREFERENCES	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Supporting Understanding	**15.5**	2.7	9.0	**12.9**	4.3	10.0	**12.5**	2.3	9.0
Transmitting Information	**16.5**	2.6	8.0	**16.5**	4.5	7.0	**17.8**	1.5	4.0

M = Mean; **SD** = St Dev; **R** = Range

The same applied for the active learners, who scored highest on the strategic approach scale and sub-scales, and the passive learners who scored highest on the surface approach scale and sub-scales. On this basis it could be concluded that learners who focus either on understanding, achievement, or simply coping with their courses in conventional instructional contexts will most probably also interact with networked environments in ways that serves these needs.

Interestingly on the course preferences scale the constructive, active, and passive networked learners all indicated a predilection towards courses in which the tutor provides explicit instruction regarding what to learn and how to learn it, rather than courses in which student autonomy is supported. However whilst the strength of this preference amongst passive and active learners is considerable, for constructive learners it is marginal. Perhaps this further indicates that in mindset constructive learners are more attuned to responding to the various demands of autonomous networked learning.

5.4.3 INDIVIDUAL APPROACHES TO STUDYING AND NL OUTCOMES

If the approaches students take to conventional studying do relate to networked learning approaches, then the ASI classification might be expected to somehow correspond to networked learning outcomes. It might also give an insight into how appropriate this particular measure of how students undertake conventional studying is when applied to determining the effectiveness with which they undertake networked learning.

TABLE 13: ASI APPROACH x MEAN INDIVIDUAL ASSIGNMENT MARKS - CASE STUDY 1

	PROBLEM SOLVING	KEY ISSUES REPORT	APPROACH MEAN
DEEP APPROACH (N 4)	62.5%	57.5%	**60.0%**
STRATEGIC APPROACH (N 6)	61.0%	60.2	**60.6%**
SURFACE APPROACH (N 0)	N/A	N/A	**N/A**
ASSIGNMENT MEAN	61.8%	58.8%	61.7%

In the context of the human factors module (Table 13), contrary to this expectation those who indicated a strategic approach to conventional studying performed slightly better, with a 60.6% mean, than those who indicated generally taking a deep approach

This reverse is observed in relation to the carbohydrate chemistry students (Figure 02), with the mean exam score for the deep approach learners, at 72.8%, considerably higher than the 49.8% of the strategic learners. However in this context the surface learners did better than the strategic learners, achieving a mean score of fifty-one percent.

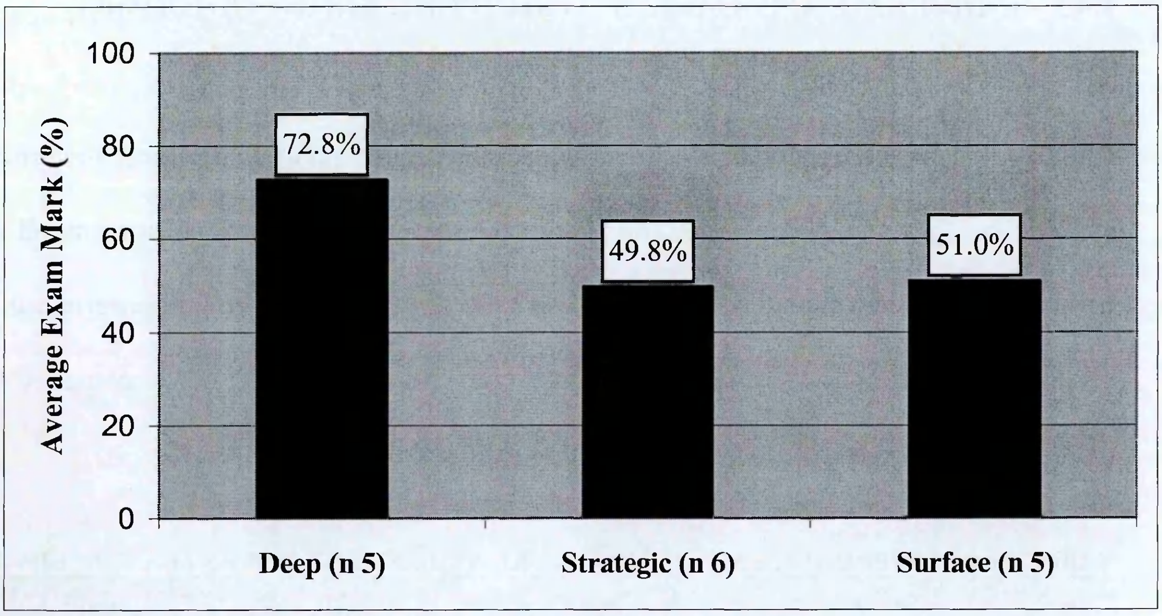


FIGURE 02: ASI APPROACH X CARBOHDRATE CHEMISTRY EXAM GRADE

It was for the students participating in the experiment that achievement was most consistent with the approach taken to conventional studying. On the written element of the periodic knowledge tests, neither of the surface approach learners was able to provide an answer beyond the multistructural level of the SOLO taxonomy, indicating they could do no more than identify several relevant issues in their answers, whilst all the test answers that showed understanding of the relationships between issues were provided by either strategic or deep approach learners. Of the eighteen (10.0%) answers at the relational level, fifteen (8.8%) were provided by three deep and three strategic learners who indicated having a preference for courses that supported understanding.

TABLE 14: ASI APPROACH x WRITTEN TESTS SOLO OUTCOMES – EXPERIMENT

	SOLO 1	SOLO 2	SOLO 3	SOLO 4	APPROACH N/%
DEEP APPROACH (N 10)	14 7.8%	27 15.0%	41 22.8%	8 4.4%	90 50.0%
STRATEGIC APPROACH (N 8)	8 4.4%	15 8.3%	39 21.7%	10 5.6%	72 40.0%
SURFACE APPROACH (N 2)	2 1.1%	9 5.0%	7 3.9%	0 0.0%	18 10.0%
TOTAL N ANSWERS **TOTAL % ANSWERS**	24 13.3%	51 28.3%	87 48.3%	18 10.0%	180 100.0%

SOLO 1 = Prestructural response; **2** = Unistructural; **3** = Multistructural; **4** = Relational response.

Finally, in the multiple-choice element of the periodic knowledge tests, the deep learners had higher factual knowledge gains, followed by strategic then surface learners.

TABLE 15: ASI APPROACH x MEAN M/CHOICE TESTS MARKS – EXPERIMENT

	TEST 1	TEST 2	TEST 3	APPROACH MEAN
DEEP APPROACH (N 10)	6.5/10	6.0/10	8.0/10	**6.8/10**
STRATEGIC APPROACH (N 8)	5.8/10	6.0/10	6.8/10	**6.2/10**
SURFACE APPROACH (N 2)	4.5/10	5.5/10	7.0/10	**5.7/10**
M/CHOICE TEST MEAN	5.6/10	5.8/10	7.3/10	6.2/10

Alongside those in the preceding section, what these findings suggest is that whilst the Approaches to Studying Inventory proved valuable in confirming a relationship between how students approached conventional and networked learning, beyond providing general evidence of the deep-surface dichotomy it provided little insight into a relationship between approaches to studying and networked learning outcomes. The implication for research into student learning via educational technology is that using measures of learning style designed for non-technological contexts, as opposed to accounting for the approaches that were actually taken, may have a restricted potential.

5.5 SUMMARY AND IMPLICATIONS

Through rigorous phenomenographic analysis of student descriptions of the networked learning experience, a diverse range of learner traits and characteristics relating to how different aspects of networked learning had been undertaken or perceived were identified. In conceptualising the likely relationships amongst them, three kinds of approach to networked learning were identified. Theoretically the constructive-autonomous approach learner is the ideal networked learner, fully pro-active in interacting with all the resources at their disposal to optimise their understanding. By comparison, the active-autonomous learner interacts purposefully but selectively with their NLE, working only with the resources they see as directly relevant to formally assessed knowledge. In contrast, the passive-autonomous learner takes a 'just-in-time' approach to studying online by accessing core materials immediately prior to deadlines, rote learns, and feels ill-suited to networked learning.

Applying the full classification scheme to the interview transcripts allowed the dominant approach exhibited by each student to be identified. This confirmed that those who had taken a constructive-autonomous approach were in the minority, and also enabled various other analyses on the influence of individual approaches to be conducted. The first major finding in the respect was in realising that the specific ways individuals undertook networked learning had a definite influence upon their ability to benefit from the affordances inherent in NLEs. Whilst the literature review and previous results chapter suggested this, the phenomenographic analysis confirmed it in two ways. One was in the character of the approach classifications themselves, as the full, selective and minimal forms of interaction that respectively typify the constructive, active and passive-autonomous approaches must increasingly lessen the scope for learning to be supported through interacting with a NLE. Further confirmation came from the individual accounts, which revealed that whilst the potential affordances of interacting with NLEs were widely perceived by students of all approach types, by and large only those classified as constructive or active-autonomous provided accounts that indicated their learning had been supported in ways consistent with how the literature describes networked learning affordances.

The second major finding concerned the influence of individual approaches upon learning outcomes. Across the case studies and experiment, those who had taken a constructive-autonomous approach were consistently the highest achievers by far, whilst their contributions to asynchronous discussion were also the most informed. Active-autonomous learners followed in terms of the quality of their knowledge, whilst those who had taken a passive-autonomous approach always emerged with the poorest understanding overall. Given that the influence of individual approaches upon realising affordances and the quality of outcomes could only be determined after each student had their approach classified, the findings in these two areas also confirm that the classification scheme produced is of descriptive worth at the broad level.

In trying to determine whether there was a link between how the same individuals approached networked learning and how they otherwise undertook studying, the main classifications within the Approaches to Studying Inventory (ASI) proved less conclusive, with only a marginal overlap in the numbers of students who exhibited the conceptually similar constructive and deep, active and strategic, or passive and surface approaches. In addition, a comparison of deep, strategic and surface approach classifications with learning outcomes was inconclusive. However a more detailed analysis of ASI data did prove insightful, with constructive-autonomous learners rating highest on all deep approach characteristics, and the equivalent occurring for the other classifications. An apparently strong relationship between approaches in networked and traditional contexts was further evidenced through the interview data.

In considering the preceding findings, a number of implications for theory and research become apparent. Regarding the nature of networked learning affordances, it is clear that there is a crucial difference between students perceiving and actually realising the potential benefits. Most of the students involved in this investigation showed an awareness of the various ways NLEs could support their learning, yet many did not interact with their environments in ways conducive to acting upon these opportunities. Therefore assuming, as much of the literature seems to, that the affordances within the features of NLEs will somehow automatically support and enhance the learning of all students in comparable ways would appear misguided.

The fact many of the students were aware of the potential learning benefits, but were limited by their individual approach in exploiting them, may also indicate that studies reliant solely on post-experience perceptions as evidence of affordances having been acted upon in practice could be inherently flawed. What it certainly confirms, as previously alluded to, is that current theory and research concerning student learning, particularly in relation to constructivist technology-based environments, is overlooking something fundamental by overlooking the role of the individual. In short, very few of the learners in this study met the constructivist ideal.

Finally, through devising a classification scheme relating specifically to networked learning approaches, it was clear that individual differences definitely had influenced learning. Perhaps this is evidence that the limited findings of research into learning styles and educational technology to date are indeed, as was considered, due to the use of existing learning style inventories that are insensitive to the nature of learning via technology. This is not to say that there is no link between how individuals learn in traditional and technology-based contexts, as a detailed analysis of responses to an established inventory in this study proved otherwise, but simply to suggest that far more insight can be gained through attempting to understand individual differences in the context of what students do and feel when using educational technology.

6.0 UNDERSTANDING MODE OF INTERACTION

Within this investigation the term 'mode of interaction' refers to the frequency with which students accessed their NLE, or parts thereof, and whether in studying the course material they did so online or offline. These related factors could be assumed to have some influence upon the effectiveness with which students undertook networked learning. Certainly those classified as taking a constructive-autonomous approach seemed to have interacted more purposively and extensively with their environments than their active-autonomous and passive-autonomous counterparts, which was reflected in their formally assessed learning outcomes. As for whether mediated material is studied online or offline, arguably it is desirable for students to learn online so as to exploit the multiple affordances inherent within NLE, although at the same time we know from previous research that students will often opt instead to work offline with printed copies of networked material (Crook, 1997b, Ward & Newlands, 1998).

The following examines the mode of interaction for the students involved in this investigation, and in relation to research objective (iv), concerns those facets of the networked learning experience that influence, and are influenced by, mode of interaction.

6.1 FREQUENCY AND READING MODE OF INTERACTION

Data relating to the frequency of interaction with the networked course material, and the extent to which this was read on or offline was provided in chapter 3. As established, most students estimated reading the materials for less than 1.5 hours each week, although a significant number read for between 1.5 and less than 3 hours. In being asked to indicate whether they read the materials exclusively online, online and offline, scanned online, or read exclusively offline, a fifth of the experimental and human factors students read exclusively online, two-fifths on and offline, and two-fifths scanned online but opted to print materials out to read properly offline. All of those who had read exclusively online were participants in the experiment, while the chemistry students were all assumed to have read entirely online because on entering the chemistry NLE the browser toolbar was automatically disabled to discourage printing.

6.2 THE INFLUENCE OF CONTEXTUAL FACTORS

In exploring the factors associated with the wider networked learning context that could have contributed towards students deciding to read material online or offline, three areas of influence emerged. There were determining factors associated with the features of the environments themselves, with the actual working space in which studying would occur, and that were more intrinsic to the individual as a learner. As illustrated in Table 01, it was those of the first type that proved influential in encouraging almost every experimental study and human factors student to read at least partially online.

With the parameters of the experiment in mind, of the factors potentially relevant to all the experimental and human factors students who read or scanned online, the most common reason for doing so was immediate access to mediated materials other than those currently being studied as the need arose. This was important to almost half of those in question (n 13), and many cited the increased efficiency in studying that reading online enabled through the consolidation of resources in one space, and the practical ease of managing non-print materials. As one student explained: "The primary advantage to having read it on-line is that it was very easy to go to different places within the website and outside it...For our weekly tasks we had to look up certain things and it was much easier than if you had taken it home, read it, and thought 'Damn, I have to look at the Glossary' or 'I have to look at this website'...It was also quicker than having to sift through reams of paper to find something" (GABU, Active-Autonomous).

TABLE 01: REASONS FOR READING/SCANNING MEDIATED MATERIAL ONLINE

	EXPERIMENT (N 20) (*N 10) (†N 9)	CASE STUDY 1 (N 9)	TOTAL N/%
Immediate access to e-mail for tutor contact if/as necessary...	7 35.0%	4 44.4%	**11**(29) **37.9%**
Immediate access to discussion facility if/as necessary...(†)	4 44.4%	6 66.7%	**10**(18) **55.6%**
Immediate access to external web links if/as necessary...	NA NA	6 66.7%	**6**(9) **66.7%**
Immediate access to other materials within NLE if/as necessary...	8 40.0%	5 55.6%	**13**(29) **44.8%**
Immediate access to web to search for material if/as necessary...	7 35.0%	4 44.4%	**11**(29) **37.9%**
To determine which materials were worth printing to read properly...	3 15.0%	5 55.6%	**8**(29) **27.6%**
For proper viewing of graphical images and animations...(*)	6 60.0%	NA NA	**6**(10) **60.0%**
Other reasons for scanning/reading mediated material online stated...	0 0.0%	0 0.0%	**0** **0.0%**

NB: Bracketed numbers in final column indicate the total number of students to which an issue applied.

The recognised absence of the spatial-temporal barriers associated with conventional instruction was also evident within three of the other reasons for reading online that the combined cohort gave. Just over a third (n 11) wanted immediate access to the web to locate assignment-related and further reading material as required, whilst the same number read online so they could contact the tutor via e-mail if and as necessary. The underlying logic was that any difficulty in understanding the topic currently being studied could be communicated at its point of occurrence rather than at a later time when it may be less clear in their mind, or have been forgotten altogether. In a similar vein, of all those with access to a discussion facility who were reading online (n 18), over half (n 10) indicated doing so in order to utilise this as they needed to. Responsive communication, with the course materials at their immediate disposal, was again the main incentive although this time for student-student discourse. From those who elaborated upon this, a typical comment was: "You've got to take part anyway, so if you're already logged on you can post a message as soon as you've got something to say. And if you need to clarify something you want to say, something from in the study notes, then you can pull them up straight away...You won't get that if you only worked on what to say away from the website" (CCHF, Constructive-Autonomous).

Of the NLE features specific to each research context, two thirds of the human factors students (n 6) indicated having read online for immediate access to the external web links provided, and over half (n 6) of those within the experiment who interacted with an environment featuring supportive visual multimedia read online so as to view such elements properly. What all these findings point towards is that certain features of networked environments, by virtue of their presence alongside and within the mediated course materials, encourage some learners to read online some of the time. This is important because presumably the more time that is spent learning online, the increased chance there is of a student being able to benefit from, for example, the opportunity to communicate their misunderstanding to the tutor at the point it occurs, to source additional knowledge and viewpoints via the web and discussion facilities, or to experience the enhanced cognition effects that are associated with visual multimedia.

However, such possibilities may not have been there for all of the students involved in this investigation because, as discovered, two-fifths (n 12) of those from the experiment and human factors module combined indicated only scanning the mediated material online, but printing it to read offline. Furthermore, amongst those who indicated having either scanned or read online (n 29), over a quarter (n 8) indicated that they scanned the material online to determine what was worth printing out to read properly. Presumably this would have greatly reduced the scope for utilising other features of the environment, or at a minimum using them when they would be of most use, because as a strategy it seems pre-occupied with obtaining hard copy of the materials to study away from the NLE. This practice might therefore, as it generally is, be seen in a negative light. Yet on examining the reasons behind why some students read partially or fully offline, it is apparent that simply polarizing online and offline reading into good and bad practice is misleading and obscures some important contextual factors, both extrinsic and relating to the individual, that may be influencing networked learning activity.

TABLE 02: REASONS FOR READING/KEEPING PAPER COPIES OF CORE MATERIAL

	EXPERIMENT (N 14)	CASE STUDY 1 (N 10)	TOTAL N/%
Kept paper copies of the materials as a general back-up...	7 50.0%	4 40.0%	**11** **45.8%**
Prefer reading from paper to reading from a computer screen...	11 78.6%	8 80.0%	**19** **79.2%**
Allowed the underlining of passages/making annotations...	5 35.7%	7 70.0%	**12** **50.0%**
Working not restricted to the times when a PC could be accessed...	11 78.6%	6 60.0%	**17** **70.8%**
Find the IT centre/workshops are not a good environment to work in...	8 57.1%	6 60.0%	**14** **58.3%**
Other reasons for reading/keeping paper copies of material stated...	0 0.0%	0 0.0%	**0** **0.0%**

Table 02 is based upon the responses of those students from the experiment and human factors module who indicated having either read or kept paper copies of the mediated course material (n 24). At a general level, the most common reason given for studying the material offline was that reading from paper was preferable to reading from the computer screen, with nearly eighty percent (n 19) in agreement. For many the problem was a physiological one, and they simply found that the act itself took more effort when text was presented electronically rather than in print format [1]. Some felt they could become as comfortable with reading online over time, but in terms of studying had preferred to rely principally upon the medium they were used to. At the same time, a preference or partial leaning towards reading from paper was symptomatic of other concerns. Chief amongst these, almost three-quarters of the students who read or kept paper copies of the material (n 17) did so because this would not restrict their learning exclusively to the times they could access a PC. As one student put it: "If I take it home I don't have to log-on. You don't have to be in college to actually read it...the main benefit is that you can read it at any time, and I can just do it whenever I want, when I'm in the mood to do it and I can concentrate on it" (LTBU, Active-Autonomous). For this reason, working offline with printed copy proved particularly valuable to those learners who did not possess their own computer, and who lived far from campus.

Another major influence upon offline reading were the conditions within the IT workshops where the majority accessed their environments. More than half (n 14) who used print-outs believed this was an issue, and cited the same problems: "In the IT centre it's not always easy to concentrate...You've got people sitting laughing, people coming and going, breathing down your neck to get on the computer, or you're thrown out because there's a class...It [printing out] was sometimes easier because I could go and find some peace and quiet to study in" (CMBU, Constructive-Autonomous). Also related to optimising the conditions for learning, half of those who had worked with paper copies (n 12) indicated that the practice enabled them to satisfy their personal preference for annotating basic course materials. For those who liked to use this

[1] It is accepted that reading an equivalent amount of text takes longer from screen than paper (Dix et al, 2003).

strategy, the efficacy of their studying was better than it would have been purely online: "In paper form I can highlight notes, main points, and write my own notes and references alongside. It's easier to do that than it is making notes of main points from sitting at the computer" (SCBK, Active-Autonomous). Finally, a considerable number of those who printed the mediated material, again around half (n 11), did so to have a back-up copy of the course content. Most had reasoned this was worthwhile so that they could study at times when working online would be impractical or impossible.

Whilst the printing out of mediated course material can broadly be observed as a negative networked learning practice, particularly for those who only ever read offline, the fact that some students did this to avoid a poor working environment, free themselves from always requiring access to a computer, or to transform the material for themselves through annotation and note-taking suggests it can also be viewed positively. Arguably, all these particular strategies are evidence of purposeful studying geared towards effective knowledge appropriation. They might even be said to reflect the conscientious effort of some individuals to overcome the time and technological restrictions of studying solely online, and through relying partially on printed copies of mediated materials participate in a literal form of any time and place autonomous networked learning. Perhaps unsurprisingly then, it was notable that such strategies were almost exclusively employed by constructive-autonomous and active-autonomous learners, the exception being printing for note-taking which was used by a few passive-autonomous learners in their attempt to 'reduce' the mediated subject area to a core of easily remembered facts and terms. Of course what must not be discounted is the familiarity with studying from paper that provided a general incentive for students of all approaches to opt for printing out the mediated material, and as was highlighted, only a fifth (n 6) of students from the experiment and human factors module combined had read exclusively online. As further testament to the allure of print over online text, it might also be noted that several of the chemistry students countered the deliberate disabling of their web browsers toolbar to obtain paper versions of the mediated materials, including using the mouse and mouse-activated menu to highlight sections of text that were copied into a word-processed document for subsequent printing.

6.3 THE INFLUENCE OF CONSTITUENT ELEMENTS

It would seem, then, that a range of factors contributed towards whether an individual read networked course materials partially or fully online or in paper form. A particular influence in encouraging online reading were the other features of the environment, and to varying extents the presence of external web links, e-mail for contact with the tutor, asynchronous discussion facilities, and supportive visual multimedia were all given as reasons for reading online. The purpose of the experimental study was to discover what role the constituent elements of an NLE might play in determining the nature and effectiveness of autonomous networked learning, and it was decided than an important aspect of this would be whether their presence had a measurable rather than perceived impact upon reading mode. As described in chapter 2, within the experiment the constituent elements that varied by their presence across the four groups, all of whom interacted with otherwise identical environments, were a discussion facility for peer debate and supportive multimedia in the form of static, interactive and animated graphics that exemplified what was discussed in the basic hypertext. The usage logs that all the participants completed collected, amongst other information, data about the frequency and duration of sessions, sessions in which the mediated material was read as opposed to scanned online, and sessions in which it had simply been printed out.

TABLE 03: READING ONLINE vs PRINTING MATERIAL – EXPERIMENTAL GROUPS

	READ MATERIAL ONLINE	PRINTED MATERIAL	GROUP N/% SESSIONS
CCGW 1 (N 4) - TEXT/MM/CMC	42 82.4%	9 17.6%	51 100/0%
CCGW 2 (N 5) - TEXT/CMC	58 78.4%	16 21.6%	74 100.0%
CCGW 3 (N 6) - TEXT/MM	79 82.3%	17 17.7%	96 100.0%
CCGW 4 (N 5) - TEXT	34 56.7%	26 43.3%	60 100.0%
TOTAL N SESSIONS TOTAL % SESSIONS	213 75.8%	68 24.2%	281 100.0%

Table 03 details the principal constituent elements within each version of the Colour in Computer Graphics Website, the number of students who interacted with it, the total number of online sessions for each group, and the number of sessions in which material was read online and printed out (these occurrences were counted individually). The findings confirm a link between features of the environment and frequency of reading online, with all but the text-only group having a high ratio of online to printing sessions. For the students presented with the most sophisticated NLE that featured text, multimedia and a discussion facility, eighty-two percent of their sessions spent interacting with the material involved reading it online, compared with eighteen percent in which it was printed. The ratio is exactly the same for the group who utilised the NLE featuring text and multimedia. It is also fairly comparable to the group presented with text-based material alongside a discussion facility, with seventy-eight percent of their sessions involving reading online against twenty-two percent printing out.

When these figures are contrasted with the group who had utilised a text-only environment, and devoted only fifty-seven percent of their sessions utilising the material to reading it online, the most obvious conclusion is that when major features like supportive multimedia and asynchronous discussion facilities are integrated within an NLE, the increased chance there is of the basic course materials actually being studied online. Although a number of the experimental and human factors students reported reading online to use a discussion facility as the need arose, the likelihood is that supportive multimedia integrated within the text of the mediated material was particularly influential in encouraging online reading. Thus it may be recalled that on the human factors module, which had an environment that contained purely text-based materials, double the number of students indicated only scanning as opposed to doing any reading online, whilst all those who reported reading exclusively online were from the experimental study. In fact, of the six that only ever read online, five had been using versions of the experimental NLE featuring multimedia. As one student put it: "The graphics definitely made you [read online], because you wanted to know what they were all about really. You could watch them but it wouldn't make much sense if you didn't read the rest of it, and if you printed it out it didn't make much sense because then you couldn't use them properly, especially the animations" (SDWH, Active-Autonomous).

In addition to determining whether the main constituent elements of a NLE would influence reading mode, the other purpose of the experiment was to discover if and how they affected networked learning outcomes. The thinking was that if the leading theories about the cognitive benefits of the educational technologies that are integrated within networked environments hold true, then it could be reflected in the achievement of students interacting with variously enhanced versions of an otherwise standard NLE. This analysis was possible through calculating the mean scores for each experimental group on the conceptual understanding and factual knowledge tests periodically completed. The mean scores for each form of test are given in Tables 04 and 05.

TABLE 04: WRITTEN TESTS SOLO OUTCOMES – EXPERIMENTAL GROUPS

	SOLO 1	SOLO 2	SOLO 3	SOLO 4	GROUP N/%
CCGW 1 (N 4) - TEXT/MM/CMC	6 3.3%	16 8.9%	14 7.8%	0 0.0%	36 20.0%
CCGW 2 (N 5) - TEXT/CMC	3 1.7%	10 5.6%	27 15.0%	5 2.8%	45 25.0%
CCGW 3 (N 6) - TEXT/MM	8 4.4%	12 6.7%	24 13.3%	10 5.6%	54 30.0%
CCGW 4 (N 5) - TEXT	7 3.9%	13 7.2%	22 12.2%	3 1.7%	45 25.0%
TOTAL N ANSWERS TOTAL % ANSWERS	24 13.3%	51 28.3%	87 48.3%	18 10.0%	180 100.0%
SOLO 1 = Prestructural response; **2** = Unistructural; **3** = Multistructural; **4** = Relational response.					

On the tests of conceptual understanding, there was no clear relationship between constituent elements and outcomes. Based purely on the make-up of the NLEs, it might be reasoned that those who interacted with the most complete environment might be at an educational advantage. However, despite being presented with supportive multimedia and a discussion facility in addition to the basic hypertext material, these students were actually the only group that failed to demonstrate any understanding beyond level three of the SOLO taxonomy. This corresponds to multistructural knowledge characterised by several relevant issues being correctly identified, but with no apparent comprehension of the links between them. All the other groups provided some answers at level four, demonstrating a relational understanding of the topic in question. Of the eighteen responses of this kind, ten were provided by students in the text and multimedia group. This was the only finding of note for this analysis.

TABLE 05: MEAN MULTIPLE CHOICE TEST MARKS – EXPERIMENTAL GROUPS

	TEST 1	TEST 2	TEST 3	GROUP MEAN
CCGW 1 (N 4) - TEXT/MM/CMC	7.3/10	6.0/10	8.3/10	7.2/10
CCGW 2 (N 5) - TEXT/CMC	4.0/10	5.8/10	6.4/10	5.4/10
CCGW 3 (N 6) - TEXT/MM	7.3/10	7.0/10	6.8/10	7.1/10
CCGW 4 (N 5) - TEXT	5.4/10	4.8/10	8.4/10	6.2/10
M/CHOICE TEST MEAN	6.0/10	6.0/10	7.4/10	6.5/10

Although the features of the different experimental environments had no direct influence on the quality of conceptual knowledge gained, analysis of the multiple choice tests indicates that exposure to multimedia might have affected the quantity of factual knowledge gained. The overall mean score for the multiple-choice tests was 6.5. Only experimental groups one and three, both of which had supportive visual multimedia within their material, surpassed this with overall group mean scores of 7.2 and 7.1 respectively. In fact these groups consistently bettered the mean score for each of the three tests, except for one occasion when it was matched and one when there was a shortfall. In comparison groups two and four, who had studied text-based material, failed to exceed the mean score for any of the three tests except on one occasion. Given that the supportive visual multimedia within the experimental environments was positively viewed, with many feeling that it contributed to their comprehension of the textual content, that there was some measurable effect is perhaps unsurprising.

Exactly how much should be made of the findings on the influence features of the environment had upon learning outcomes is difficult to determine. Exposure to multimedia seemed to play a part in how much factual knowledge was gained, although the small numbers involved in the experiment, which was an exploratory-level study, demand a degree of interpretative caution. Regarding the conceptual learning outcomes of the experimental groups, the fact that the discussion facilities were not particularly well-used for general subject-related debate could be another reason for there being no clear difference between groups in this context. However there is another possibility to consider in attempting to understand whether there is a link between features of the environment and achievement, and that is the intervening role individual approaches, already found to directly affect learning outcomes, might be verified as having.

6.4 THE INFLUENCE OF INDIVIDUAL APPROACHES

When cross-referenced with networked learning approach classifications, the data from the experiment, and that collected through the returned usage logs, enabled a detailed analysis of how individual approaches influenced general mode of interaction, frequency of using various NLE features, and the resulting learning outcomes. As stated in the methodology, the usage logs were devised to compensate for the availability of poorly detailed web server statistics. As can be the case with such tools not all usage logs were returned, although of the thirty-nine that were the data from them certainly seems to correspond with key findings of the naturalistic investigation.

TABLE 06: NL APPROACH x WEEKLY READING TIME FOR CORE MATERIAL (Estimated)

	<1.5 HOURS	>1.5 <3 HOURS	> 3 < 4.5 HOURS	APPROACH N/%
C-A APPROACH (N 11)	7 63.6%	3 27.3%	1 9.1%	11 100.0%
A-A APPROACH (N 18/19)	10 55.6%	8 44.4%	0 0.0%	18 100.0%
P-A APPROACH (N 16)	12 75.0%	4 25.0%	0 0.0%	16 100.0%
TOTAL N **TOTAL %**	29 64.4%	15 33.3%	1 2.2%	45/46 100.0%

Addressing first the general mode of interaction, Table 06 gives the estimated weekly average times for reading the mediated material obtained via the post-experience questionnaire, and grouped according to the approach classifications of all students in the investigation (there was one non-response to this particular question). As was established, a two-thirds majority read the material for under 1.5 hours per week, with one-third reading for between 1.5 and 3 hours, and only one individual reading in excess on 3 hours. What becomes interesting when analysed by approach is that the highest majority of all approach classifications is for the three-quarters of passive-autonomous learners (n 12) who read for less than 1.5 hours, and also had the lowest majority (n 4) of those who had read for between 1.5 and 3 hours. The active-autonomous learners had the highest majority in this category, whilst the sole individual who averaged reading the mediated course material for more than three hours a week turned out to have been constructive-autonomous in approach. Although this provides only a basic indication of the time invested in networked learning, this data shows the students of each approach type basically conforming to the patterns of behaviour they had described verbally, with passive-autonomous learners investing the minimal effort.

TABLE 07: NL APPROACH x HOURS AND NUMBER OF SESSIONS ONLINE

	TOTAL N HOURS	MEAN HOURS	TOTAL N SESSIONS	MEAN SESSIONS
C-A APPROACH (N 9/11)	47.25	5.25	90	10
A-A APPROACH (N 18/19)	76.5	4.25	169	9
P-A APPROACH (N 12/16)	37.0	3.0	80	7
TOTAL N	160.5	4.0	339	9
NB: Hours rounded to nearest quarter.				

This general pattern is reflected, and is also more pronounced, in the frequency of online activity for each approach type (Table 07). Based on an accumulation of usage log data for the different groups, it is clear that the students who had taken a constructive-autonomous approach proportionally spent the longest amount of time online, with each individual averaging 5.25 hours over ten sessions. Active-autonomous students followed, averaging 4.25 hours online over nine sessions, whilst those who had taken a passive-autonomous approach averaged a poorer three hours over seven sessions. Again this serves to confirm one of the main understandings of the arrived at through the phenomenographic research, which is that constructive-autonomous networked learners are the most thorough in interacting with NLEs, and that passive-autonomous networked learners possess the weakest studying 'work ethic'.

Further evidence of this is to be found in examining how fully students of each approach interacted with the various features in their NLE. Data derived from the chemistry case study, the environment for which was the richest in material and constituent elements out of the three research contexts, and which had also had a reasonably varied split between the different approach types, is suitable for this purpose.

TABLE 8: NL APPROACH x INTERACTION WITH CORE MATERIALS - CASE STUDY 2

	C-A (N 3)	A-A (N 6/7)	P-A (N 3/6)	TOTAL N/% SESSIONS
THEORY SECTION 1	11 28.9%	21 55.3%	6 15.8%	38 100.0%
THEORY SECTION 2	4 12.1%	23 69.7%	6 18.2%	33 100.0%
THEORY SECTION 3	6 22.2%	18 66.7%	3 11.1%	27 100.0%
THEORY SECTION 4	8 36.4%	13 59.1%	1 4.5%	22 100.0%
GLOSSARY	16 45.7%	16 45.7%	3 8.6%	35 100.0%
N SESSIONS FOR APPROACH % SESSIONS FOR APPROACH	45 29.0%	91 58.7%	19 12.3%	155 100.0%

C-A = Constructive-autonomous approach; **A-A** = Active-autonomous; **P-A** = Passive-autonomous.

Table 08 comprises the total number of sessions in which each section of the course material was accessed overall, and by students of different approaches. Although an analysis that accounted for how long was spent within sections of the material was not possible, what is apparent is that the activity of the three constructive-autonomous learners was reasonably evenly spread across the material, which would be expected given that they were found through their descriptions to have read most broadly. Active-autonomous learners were characterised in part by selective reading, essentially focusing only on the content and sections of material they regarded as most relevant to their assessed work. Accordingly it was found their online activity tailed off towards the later sections of the mediated material, and particularly the last one. It was this section, on glycoside chemistry, that many active-autonomous learners pinpointed as most surplus to their exam requirements. Lastly, it was the reading of passive-autonomous learners that lacked most direction, characterised by skim-reading and often limiting their efforts to introductory content. Consequently these learners, within the chemistry module, barely interacted with the course material beyond the first two sections.

With regards to how the other features of the carbohydrate chemistry environment were utilised (Table 09), proportionally the constructive-autonomous learners made more use of the interactive 3-D chime models and the online assessments. Although as discussed previously the chat facility was not used at all, for which there were various possible causes, it was the constructive learners who showed most willing to have used the facility by frequently accessing it to check for contributions. The active-autonomous learners also interacted fairly fully with the additional features at their disposal, including particularly the chime models, online assessments, and also the progress checkpoints. In contrast with the constructive-autonomous and active-autonomous learners, the passive-autonomous learners made scant use of the chime models incorporated within the mediated material, and never used any of the other major constituent elements. Again, the reluctance of such students to engage more than minimally in the experience of autonomous networked learning is clear.

TABLE 09: NL APPROACH x UTILISATION OF SUPPORTING FEATURES - CASE STUDY 2

	C-A (N 3)	A-A (N 6/7)	P-A (N 3/6)	TOTAL N/% SESSIONS
3-D CHIME MODELS	9 33.3%	14 51.9%	4 14.8%	27 100.0%
ONLINE ASSESSMENTS	7 38.9%	11 61.1%	0 0.0%	18 100.0%
PROGRESS CHECKPOINTS	4 22.2%	14 77.8%	0 0.0%	18 100.0%
EXTERNAL WWW LINKS	2 33.3%	4 66.7%	0 0.0%	6 100.0%
CHAT FACILITY (TO READ)	7 63.3%	4 36.4%	0 0.0%	11 100.0%
E-MAIL LINK TO TUTOR	0 0.0%	1 50.0%	1 50.0%	2 100.0%
N SESSIONS FOR APPROACH **% SESSIONS FOR APPROACH**	29 35.4%	48 58.5%	5 6.1%	82 100.0%

C-A = Constructive-autonomous approach; **A-A** = Active-autonomous; **P-A** = Passive-autonomous.

With the learners of each approach type interacting with their networked environments to such varying degrees of frequency and completion, the final question that might be asked of the interrelationship between approach, mode of interaction, and features of the environment is whether this extends to influencing outcomes. Some evidence for this was forthcoming from the experimental study data when mean scores on the conceptual understanding and factual knowledge tests were based on approach classification, and crossed with exposure to supportive visual multimedia (for the previously observed reasons, an analysis based upon interaction with discussion facilities was not feasible).

Table 10 shows the conceptual knowledge test outcomes by approach for students that used versions of the experimental environment featuring multimedia-enhanced material, and Table 11 those for students who used versions featuring text-only material.

TABLE 10: NL APPROACH x SOLO OUTCOMES FOR MULTIMEDIA NLEs - EXPERIMENT

	SOLO 1	SOLO 2	SOLO 3	SOLO 4	APPROACH N/%
C-A APPROACH (N 4)	4 2.2%	5 2.8%	17 9.4%	10 5.6%	36 20.0%
A-A APPROACH (N 1)	2 1.1%	3 1.7%	4 2.2%	0 0.0%	9 5.0%
P-A APPROACH (N 5)	8 4.4%	20 11.1%	17 9.4%	0 0.0%	45 25.0%
TOTAL N ANSWERS TOTAL % ANSWERS	14 7.8%	28 15.6%	38 21.1%	10 5.6%	90 50.0%

SOLO 1 = Prestructural response; **2** = Unistructural; **3** = Multistructural; **4** = Relational response.

Within each condition the constructive-autonomous learners attained the highest levels of conceptual understanding, with the one individual who studied text-only material providing three of the eight answers at the relational level of the SOLO taxonomy, and the four constructive-autonomous learners who studied multimedia-enhanced material providing all ten of the relational answers in their group. Again the small numbers hamper any definite conclusions, and the six active-autonomous learners who studied text-based material yet provided five answers at the relational level must be acknowledged, but the findings could indicate that constructive-autonomous learners who were provided with multimedia were the highest achievers. No passive-autonomous learner in either condition responded above a multistructural level.

TABLE 11: NL APPROACH x SOLO OUTCOMES FOR TEXT-ONLY NLEs - EXPERIMENT

	SOLO 1	SOLO 2	SOLO 3	SOLO 4	APPROACH N/%
C-A APPROACH (N 1)	1 0.6%	1 0.6%	4 2.2%	3 1.7%	9 5.0%
A-A APPROACH (N 6)	5 2.8%	10 5.6%	34 18.9%	5 2.8%	54 30.0%
P-A APPROACH (N 3)	4 2.2%	12 6.7%	11 6.1%	0 0.0%	27 15.0%
TOTAL N ANSWERS TOTAL % ANSWERS	10 5.6%	23 12.8%	49 27.2%	8 4.4%	90 50.0%

SOLO 1 = Prestructural response; **2** = Unistructural; **3** = Multistructural; **4** = Relational response.

As for achievement on the multiple choice tests, mean scores are provided in Table 12 for the text-based material and, Table 13 for the multimedia-enhanced material.

TABLE 12: NL APPROACH x M/C TEST MARKS FOR TEXT ONLY NLEs - EXPERIMENT

	TEST 1	TEST 2	TEST 3	APPROACH MEAN
C-A APPROACH (N 1)	4.0/10	8.0/10	10.0/10	**7.3/10**
A-A APPROACH (N 6)	4.5/10	5.0/10	7.2/10	**5.6/10**
P-A APPROACH (N 3)	5.3/10	5.0/10	7.0/10	**5.8/10**
M/CHOICE TEST MEAN	4.7/10	5.3/10	7.4/10	5.8/10

Factual knowledge gains were down for all those who only studied text-based material, and their 5.8 overall mean score was considerably poorer than the 7.1 mean score of those who had studied multimedia-enhanced material. At an approach level, the text-based learners consistently had lower scores than their multimedia-enhanced peers, although within both conditions constructive-autonomous learners were the highest achievers. Again this might suggest that a constructive-autonomous approach combined with a rich rather than a simple text-based NLE provided the optimum conditions for effective networked learning, and corresponds with the previous chapter's findings that constructive learners interact most pro-actively with their NLEs, and as a result consistently achieve more on formal assessments of networked learning outcomes.

TABLE 13: NL APPROACH x M/C TEST MARKS FOR MULTIMEDIA NLEs - EXPERIMENT

	TEST 1	TEST 2	TEST 3	APPROACH MEAN
C-A APPROACH (N 4)	8.8/10	7.5/10	8.3/10	**8.2/10**
A-A APPROACH (N 1)	8.0/10	4.0/10	10.0/10	**7.3/10**
P-A APPROACH (N 5)	6.0/10	6.4/10	6.2/10	**6.2/10**
M/CHOICE TEST MEAN	7.3/10	6.6/10	7.4/10	7.1/10

6.5 SUMMARY AND IMPLICATIONS

The term 'mode of interaction' is taken to mean the frequency with which the students undertook learning via their NLEs, and whether in studying course materials they did so on or offline. Through relating to the time invested in learning, and the scope for interacting with resources that can only be fully utilised online, it was assumed these factors would have some degree of influence upon networked learning effectiveness.

For this reason, and also because they have rarely been a major focus of previous research, it was felt that a detailed exploration of these issues would prove particularly beneficial – and at the very least provide some useful additional insight into the nature of individual approaches to networked learning. The resulting data did prove valuable in this particular respect, as well as in highlighting other aspects of the networked learning experience that influence, or are influenced by, mode of interaction.

In summary, as was previously established, few students read exclusively online, with most reading on and offline or scanning material online before printing it out to read more fully. For those who read online, most did so to access other resources as required, to properly view multimedia, or to determine which materials were worth printing out. The most popular reasons for working with printed material were a preference for reading from paper, and to avoid being restricted to the times when they could access a computer. Many students also felt the conditions in IT labs were not suited to studying, and half worked with paper to enable note-taking and annotations. In the experiment, the number of sessions in which material was read online versus printed out was around the ratio of eight to two for NLEs that featured multimedia and/or a discussion facility. For the text-only NLEs it was six to four. There was no effect of NLE features on conceptual knowledge gains, although those presented with supportive multimedia performed best on multiple-choice tests

Constructive-autonomous learners spent more time over more sessions online than active-autonomous and particularly passive-autonomous peers. Their reading was distributed across the course materials, and they made heaviest use of multimedia and other features. Passive-autonomous learners read initial sections of material only, and failed to use most other features. There was also tentative evidence from the experiment to suggest the most effective learners were constructive-autonomous individuals with access to multimedia, where as text-based learners of all approach types had faired less well than their multimedia counterparts on multiple choice tests.

In considering these findings what first becomes evident is that whilst offline reading arguably limits the potential for students to utilise the more interactive features of NLEs, reading online versus offline cannot be seen purely terms of good and bad networked learning practice. Evidently these practices were not always mutually exclusive, and many students who did read at least partially offline were doing so to overcome the limitations of networked learning, for example to avoid studying in a poor physical environment, to personalise the material, and most tellingly to undertake studying in a genuinely anytime, anyplace manner. Whilst many students will have worked primarily offline simply because that is what they are used to, it should perhaps be more widely recognised that for some students and situations, undertaking networked learning partially offline can have real advantages.

Regards whether studying occurs on or offline, the role that non-text features play in determining how students generally interact with networked environments has received little attention. In the context of this research it was apparent that the presence of visual and other interactive features, especially multimedia, did actually encourage some online studying. Many students went online specifically to interact with these features, and far less printing of course material occurred than amongst students who were using a text-based environment. Given this effect of their presence, and the fact that supportive multimedia did clearly influence learning outcomes, this suggests that visual and interactive features have a dual role to play both in facilitating online studying and effectively enhancing learning. A pertinent question might be to ask whether in encouraging the former, the presence of such features in turn leads to increased interaction with other tools and resources? It might also be asked whether some studies reporting excessive printing have been limited by concerning networked environments that were largely text-based in content?

Finally, by confirming the descriptions of experience provided in the interviews, the quantitative data concerning mode of interaction lends further credence to the descriptive worth of the approach classifications developed. In short, the most effective learners in terms of interacting with their environments over time were found to be those previously classified as having taken a constructive-autonomous approach, followed by active-autonomous learners, and with passive-autonomous individuals exhibiting the weakest networked learning work ethic overall.

7.0 TOWARDS A THEORETICAL FRAMEWORK

Having examined the theory relevant to networked learning, and considered the findings of this investigation in relation to student perceptions of their networked learning experience, the distinct ways in which individuals approached networked learning and the influence this had upon learning effectiveness, and the issues surrounding mode of interaction with NLEs, what follows is an attempt to consolidate what has come to be understood in these different areas in order to satisfy the main aim of this research and arrive at an understanding of the nature of autonomous student interaction with web-based educational environments. To facilitate this, presented below is the content for a theoretical framework that, based on the preceding work, proposes to conceptualise the possible relationship between individual approaches to networked learning, interaction with autonomously accessible NLEs and their features, and learning outcomes.

7.1 SCOPE AND CONCEPTUAL FOUNDATION

A theoretical framework can be defined as "a logically developed, described and elaborated network of associations among variables that have been identified through such processes as interviews, observations and the literature survey" (Sekaran, 1992, p. 73). Theoretical frameworks are intended to be descriptive in nature. In relation to interpretative social research Mason (1996) observes how "descriptive explanation may involve the construction of some kind of explanatory account of what is going on in a particular social location, or of the operation of a set of social processes", but stresses the importance of such descriptions being clear about what have been selected as the explanatory factors, and upon which assumptions the description hangs (p. 137).

In terms of descriptive scope, in seeking to explain the nature of student interaction with networked learning environments, the key factors relevant to this embryonic framework are the individual approaches to networked learning this research identified, the common features of typical networked environments, and those instructional and other contextual factors that are likely to influence how students undertake, perceive and also benefit from networked learning. As for how widely applicable the explanation offered in this framework might be, it should be recognised that is based upon these factors having been investigated in the context of full-time, undergraduate campus-based students interacting autonomously with networked environments that were the sole or intended primary method of course delivery for a particular module, and with the students in question used to lecture-based courses and new to learning fully online.

In terms of conceptual foundation, consistent with the theoretical and methodological approach of this thesis, this framework is based on an acceptance of the assumptions and beliefs of constructivist learning theory, a recognition of the concept of affordances as it relates to the potential benefits of educational technology, and an acceptance of what previous phenomenographic research has discovered about the nature of student learning in higher educational contexts. Essentially, in addressing the nature of student interaction with NLEs this framework has three underlying beliefs:

1. Instructional environments which support student autonomy, reflection, and collaboration in the completion of realistic tasks using a diverse range of resources can support the development of rich, transferable knowledge.

2. Inherent in the specific features and tools of networked learning environments are certain properties that have the potential to support and enhance cognition in ways that are consistent with constructivist ideas of student-centered learning.

3. Individual students have preferred ways of approaching studying that influence how and what they learn, but which are open to influence by factors such as the nature of learning tasks and perceptions of learning objectives.

7.2 THE NATURE OF AUTONOMOUS NETWORKED LEARNING

The central proposition of the proposed framework is that the nature of autonomous networked learning, which is basically taken to mean how the individual undertakes networked learning and the educational effectiveness of the experience for them, can on the basis principally of the empirical findings but also relevant theory and previous research be conceptualised in terms of an interrelationship between an individual's approach to networked learning, mode of interaction with their NLE, and the features of the environment itself in the form of course content, activities, and other instructional and extrinsic factors. This three-factor interrelationship is depicted in Figure 1.

Within the proposed framework, the individual approach of the student is to be viewed as having the strongest influence on how, and how effectively, a student undertakes networked learning. However the relationship between individual approach, mode of interaction, and the NLE should indeed be seen as an 'inter-relationship' as a clear degree of inter-dependence between them is often evident, or at the very least strongly implied based both on the empirical findings and the insights that can gained from the literature. As an example in the former vein, the passive-autonomous, active-autonomous and constructive-autonomous approaches had clearly corresponded to increasing amounts of time spent studying and increasingly pro-active use of NLEs, both of which are important factors in defining an individual's mode of interaction with networked environments, and also to the qualitatively better networked learning outcomes in all three research contexts.

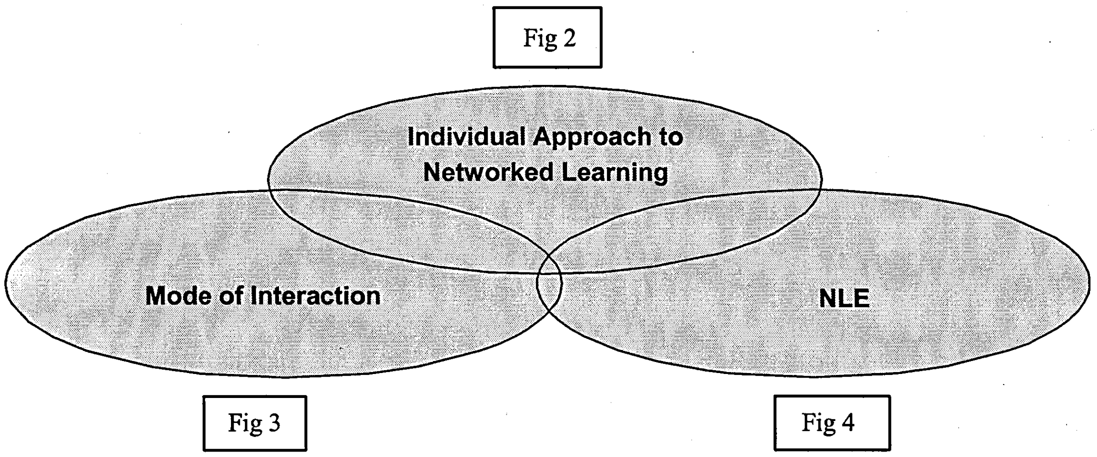


Figure 1: The Nature of Autonomous Networked Learning

As an example of their implied inter-dependence, many of the human factors students stressed the need for clearer learning objectives in the assignment-related information provided in their environment, whilst the chemistry students had been uncertain of the purpose of their environment, and how to use and operate certain features of it, due to the poor instructional and technical guidance available online. As is known from previous phenomenographic research, a good understanding of task can be a major influence on the learning approach taken, whilst the literature review also highlighted the importance of explicit guidance to aiding the good use of educational technologies (e.g. Harasim et al, 1995; Relan & Smith, 1996; Collis & Meeuwsen, 1999).

The nature of networked learning as depicted in the above diagram is at a very broad level of conceptualisation, with a fuller understanding to be achieved through considering the nature of each of the three main factors, and specifically in terms of their own influencing factors. The proposed nature of each of the three main factors depicted in Figure 1 are illustrated within Figures 2, 3 and 4 that are subsequently presented in this chapter. Figures 2, 3 and 4 respectively relate to the key factors and influences involved in determining the nature of individual approaches to networked learning, of a student's mode of interaction with their NLE, and of the NLE itself.

The depiction of important inter-relationships in diagrammatic format is intended to communicate the fundamental aspects of the framework in a more readily usable, economic form. This practice is thought to aid the wider dissemination and potential application of qualitative analysis and theory (Coffey & Atkinson, 1996).

7.3 THE NATURE OF INDIVIDUAL APPROACHES TO NL

On the basis of the phenomenographic research that was the focal element of this investigation, the main proposition here is that students undertake networked learning in one of the three distinct and increasingly sophisticated ways identified, with each successive approach on the passive-active-constructive continuum more conducive to realising the potential benefits inherent in NLEs, and developing a better understanding of the mediated subject area. However, whilst the passive-autonomous, active-autonomous and constructive-autonomous approaches are reflective of how different individuals respond to the demands of networked learning, a second proposition is that these approaches and their traits can largely be viewed as an 'emergent property' of an individual's preferred approach to traditional studying, ease with the nature of networked learning, ease with technology, and understanding of course objectives (as shown in Figure 2 The Nature of Individual Approaches to Networked Learning).

Despite inconsistencies in findings across previous studies, many nevertheless provide some evidence that existing learning styles can influence interaction with, and the quality of learning from, hypertext-based environments (e.g. Lee & Lehman, 1993; Jacobson et al, 1996; Rasmussen & Davidson-Shivers, 1998, in addition to the several studies previously discussed that used cognitive style measurements) and networked learning environments (e.g. Loomis, 2000; Federico, 2000; Karrupan, 2001). All of this research used instruments designed to assess learning styles in general, organisational or traditional educational contexts, and although they provide limited insight for this reason, they do suggest that how students typically like to undertake learning can be an influence in educational technology-based contexts. Generally, those students who can be considered more active or self-dependent in learning style interact more extensively with their environments, and usually have the better learning outcomes. In relation to networked learning, the aforementioned and other similar studies suggest these types of learners enjoy networked learning the most, and also view it more positively.

In relation to the approaches to studying construct, there is some evidence to suggest that those who take a deep or strategic approach in conventional course contexts are better suited to coping with what networked learning entails, and interact more effectively with the resources at their disposal (Allinson, 1992; Light et al, 1997; Gibbs, 1999). The empirical element of this investigation supported the idea of a relationship existing between how at least some students typically approached studying, and how they approached networked learning. This was perhaps most obvious within the descriptions of experience provided by the students, who often explained how they undertook networked learning in ways that indicated they were essentially adhering to their normal practices in terms of time management, what they focused on when studying the networked course material, and their use of other available resources. It was also evident when comparing networked learning approach classifications with responses to the Approaches to Studying Inventory at a sub-scale level relating to the traits respectively associated with the deep, strategic and surface approaches. This analysis found that the constructive-autonomous learners scored highest on all the deep approach traits, the active-autonomous on the strategic traits, and the passive-autonomous on the surface traits. Whilst strongly indicative of a relationship between how the students undertook conventional and online learning, this in itself is perhaps unsurprising given that the underlying focus or orientation of each networked learning approach type – understanding for the constructive-autonomous approach, achieving for the active-autonomous approach, and coping for the passive-autonomous approach – are the same as those that respectively define the deep, strategic and surface approaches.

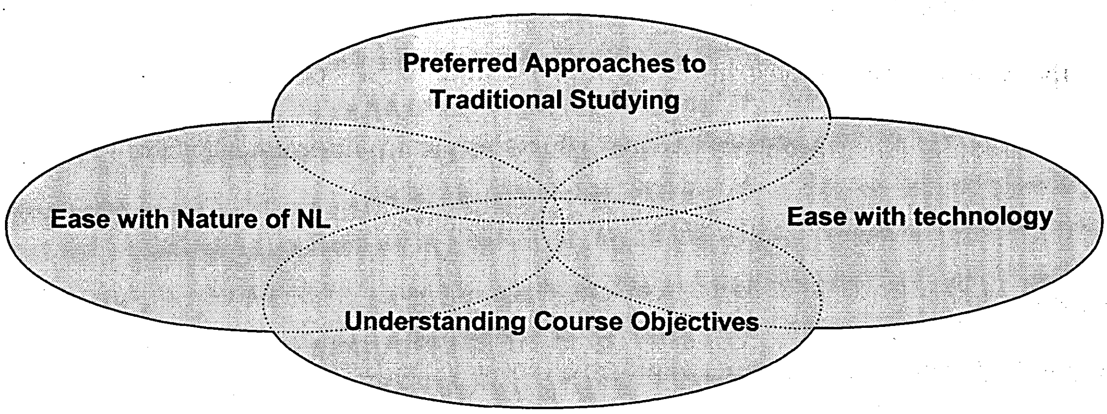


Figure 2: The Nature of Individual Approaches to Networked Learning

As regards how at ease with nature networked learning a student feels, previous research has consistently shown that whilst many students feels positively about networked learning and the opportunities it offers them, the majority of students are typically opposed to the prospect of learning solely via a NLE on any course or module (Bostock, 1998; Ward & Newlands, 1998; Angulo & Bruce, 1999; Shaw, 2000). This was also a key finding from the research element of this investigation. Part of the reason for this reluctance, as a number of the aforementioned authors suggest, is that many students do not seem to possess the appropriate mindset or skills to learn successfully in a networked learning context, and as a result are less open to, and able to function in, fully online situations. There is certainly a relationship here with the approaches to networked learning identified. A key characteristic of the constructive-autonomous approach was feeling fully able to cope with what networked learning involves, and having a preference for networked learning as a primary means of course delivery. Conversely, a key characteristic of the passive-autonomous approach was a need for the kind of structured studying and support normally associated with lecture-based courses, which was closely linked with very poor self-motivating ability. Perhaps most tellingly, passive-autonomous learners, and to a much lesser extent active-autonomous learners, indicated a dislike for networked learning or aspects of it because of the ways in which it was different from a lecture-based course. Passive learners had the least conscious awareness of what networked learning offered that lecture courses did not, where as constructive-autonomous learners were more alert to the benefits.

On one level, being at ease with technology is a given requirement for effective networked learning. An individual who might otherwise be pre-disposed towards taking a constructive-autonomous approach to networked learning will encounter difficulty if they do not possess the necessary computer and internet skill. That is, they must be able to operate the technology itself at the minimally required level before they can properly engage in studying online. However, the vast majority of the students in this investigation were equipped to this level. There is therefore a more pertinent issue, one closely related to how at ease with nature of networked learning a student is, and that is their ease with using the technology for educational purposes. This lies in the difference, for example, between knowing how to read and post messages to a discussion board, and actually appreciating and feeling comfortable with what such facilities offer and entail in terms of communicating asynchronously with peers and tutors. In the context of a specific course or module, it also lies in the difference between technical competence and understanding how the available resources are intended to support learning, coupled with a willingness to use them in the ways that are conducive to this. There are many aspects to this. As established, passive-autonomous students seemed least aware overall of how their environments might have successfully supported their learning, and certainly used them less purposively than active or constructive-autonomous learners. However personal preferences about which students are fully aware also play their part, from the minority who might find the idea of making their opinions visible via an asynchronous discussion intimidating, to those who may rely so heavily on working with printed copies of networked course material that they leave themselves with little scope for using other features of the environment.

In the context of a specific networked course or module, the proposed framework contends that what students understand about the resources and materials on offer, and the learning they are intended to support, will largely depend on the nature of the course objectives communicated to them. It is suggested that in networked learning contexts, course objectives can be taken to include not only the learning objectives communicated in module and task descriptions, but also the information that is communicated to students about how the environment is intended to support their learning, and how it should therefore be used or operated to ensure this does happen. The framework contends that what students understand from the course objectives communicated to them will influence, possibly in fundamental ways, aspects of the approach taken.

In relation to learning objectives, early phenomenographic research set a precedent for this in showing that when students perceived a task to require a demonstration of conceptual knowledge they focused on the meaning in a prose, and when they saw it to require a demonstration of factual knowledge they tried to memorise key facts and terms (Marton & Saljo, 1976b). This was regardless of their preferred approach type, and subsequent phenomenographic continues to attest to the influence of learning objectives, and perceptions of them, on learning effectiveness (Entwistle, 1998).

For the students involved in this investigation, there were several instances in which the course objectives communicated to them proved problematic and resulted in less than optimum interaction with their NLEs. For the human factors students there was confusion over which resources to use and direction to take due to the perceived poor quality of a particular assignment specification, while there was no use of the discussion facility in the experiment despite some individuals having been prepared to participate partly because nothing was communicated about how this was to be used. The lack of explicit information provided about the purpose of the chemistry environment and how to interact with it actually prevented many students from using the NLE and various features within it more actively than they did and were prepared to. As a number of these kinds of instance applied to the majority of the students within the respective contexts, the implication is that they affected individuals of all approach types. Had clearer course objectives been communicated within these situations, then presumably at least active-autonomous and constructive-autonomous learners would have made more effective use of their environments where they otherwise made limited or no use of particular features. As for passive-autonomous individuals, who make minimal use of their environments and feel ill-at ease with networked learning, clear learning objectives detailing what specific tasks and assignments required would be essential.

Yet perhaps just as importantly this kind of learner would benefit particularly from more explicit guidance not just on the resources available within NLEs and how to use or operate them, but on why studying visual multimedia, following up on external links, participating in online discussion, etc are good ideas and would aid their learning. More broadly, this implies that some explicit guidance on how to study online effectively could be communicated to help some learners in taking the best approach they can.

7.4 THE NATURE OF MODE OF INTERACTION WITH NLEs

In the proposed framework, mode of interaction, that is the frequency of interaction and extent to which interaction with mediated course material occurs online or offline, is seen as being subject to four influencing factors comprising individual approach, features of the NLE, reliance on print materials, and studying conditions (Figure 3).

Individual approach to networked learning is the major factor affecting how much time is spent studying, in addition to how well this time is organised, with the constructive-autonomous approach learners identified having invested far more time in networked learning than their active-autonomous and passive-autonomous peers, and in contrast with the passive-autonomous learners studied consistently throughout. Constructive-autonomous learners also made more use of the range of the resources at their disposal, essentially exploiting their environments as fully as possible, with active-autonomous learners using their NLEs selectively, and passive-autonomous learners minimally. The basic constructive-passive dichotomy is supported by the previously discussed prior research on learning styles and interaction with educational technology, which normally finds students with independent, meaning-focused styles interact with technology-based educational environments more extensively than students with less pro-active styles.

It is proposed that specific features of the environment influence the amount of networked learning that actually occurs online on the basis of the findings from the experimental aspect of this investigation. Those students who were interacting with environments that featured supportive multimedia and or asynchronous discussion facilities had a much higher ratio of reading online versus reading offline than those who used a text-only environment. The presence of supportive visual multimedia was particularly important in this respect, with many students explaining that they read at least partially online in order to properly view the static images, and especially to utilise the more interactive multimedia elements. In addition a number of students had opted to sometimes read online so as to access their discussion facility when they required it.

If by virtue of their presence such features encouraged learners to study online, then this has certain implications. Firstly, if students opt to work online because, for example, supportive visual multimedia is available to be viewed and interacted with, then presumably at least some individuals will interact with it in ways that are conducive to their cognition effectively being supported (which the nature of the approaches identified confirm). In addition, to engage learners online in what need to be predominantly online learning contexts if the student is to benefit as fully as possible from the resources available, then perhaps the deliberate inclusion of relevant supportive multimedia and other interactive features, by encouraging increased online interaction, would lead to increased use of e-mail or discussion facilities to seek assistance at the point of it being needed, of external links to further reading to gain further insight into a particular issue, or of the web to source other relevant materials. This is highly speculative, and not aided by the influence of NLE features on mode of interaction with online environments being an under-researched issue, but the findings in this area of the investigation do suggest it is one that should be accounted for.

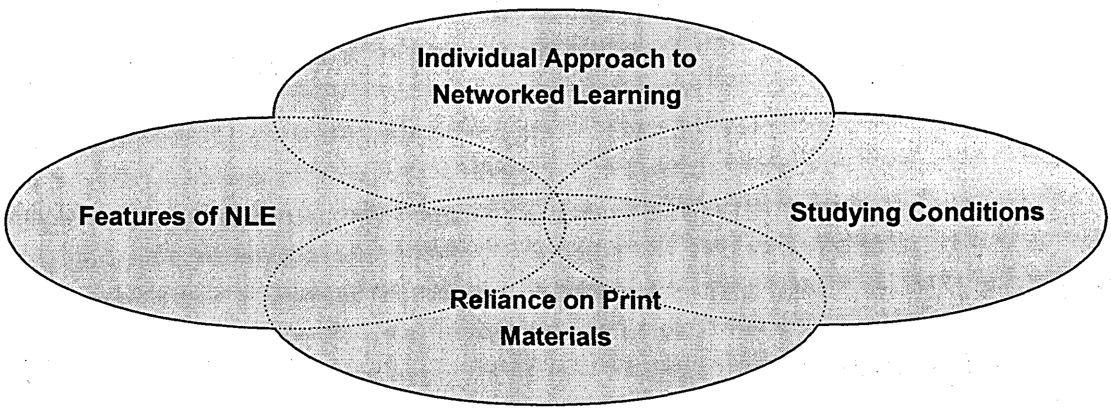


Figure 3: The Nature of Mode of Interaction with NLEs

Any influence that specific features of the environment have upon how much interaction with mediated material occurs online will probably be offset to some degree by any preference or reliance the individual has for working with print-based materials. For some this will be a physiological issue, and they will find it harder to read from screen than from paper. An aspect of this might be that reading from paper-based materials is simply what they are used to, while reading purposively from screen, as opposed to scanning information online, is something they have yet to become accustomed to. Yet for other students, including many of those constructive-autonomous and active-autonomous learners identified within this investigation, any preference for working with print materials could be at least partially based on their desire to employ the established studying strategies, such as annotating and cross-referencing, that they find personally effective in making sense of course material. There were also those who felt that keeping a paper-based copy of the core materials allowed them to study away from the computer in a literal anytime, anyplace sense. In both these respects then, it should be expected that some networked learners will print materials to get around what they find to be limiting about studying online, which in turn suggests that whilst the excessive offline reading of networked material is problematic for all the reasons observed within this investigation, the basic practice can be educationally effective.

The final factor expected to influence mode of interaction with NLEs are the studying conditions associated with the physical space from which the environment is being accessed. This is an important issue for many students who are accessing NLEs mainly or solely from on-campus IT laboratories, which are often felt to be poor environments for sustained periods of study due to noise, the movement of students to and fro, and the threat of booked workshops or terminals interrupting work in progress. This can also often result in students working with paper-based materials, online at home if that is an option, or even in IT labs but out with preferred times for studying, as evidenced by this and previous research (e.g. Ward & Newlands, 1998; Beasley & Smyth, 2004).

7.5 THE NATURE OF THE NETWORKED LEARNING ENVIRONMENT

The third element in the main three-factor inter-relationship that determines the nature of autonomous networked learning is the nature of the networked learning environment itself (Figure 4). This is taken to encompass both the features of the environment and the instructional factors directly associated with it, including the quality of the mediated course materials, the other constituent elements and technologies, the nature of the interaction with tutor and students, and the form of learning activities and assessments.

The quality of the mediated course materials is partly determined by the level and clarity of core subject materials within the environment, but also any additional materials the environment provides external links to. The explanatory breadth, depth and understandability of the core materials was felt by the students to be critical to the success of learning in largely independent networked contexts which required the student to have increased ownership of the learning process, and provided no real opportunities beyond re-reading to seek immediate assistance with comprehending the basic content of the subject material. The quality of the mediated course materials is also partly determined by the clarity and comprehensiveness of administrative information covering the organisation of the module, learning objectives, assignment specifications, and instruction on how to operate the environment. The importance of this information being clear and complete is, as has been established, vital to ensuring that the majority of students are in a position to undertake networked learning, and in doing so utilise their NLE and the resources it features as effectively as possible.

Yet is also evident, as was previously alluded to, that many students might be helped in undertaking networked learning from detailed guidance on how to interact with their environments, rather than just what they are generally intended for and how they are to be operated on a technical level. This suggests good metacognitive-level information designed to support specific kinds of interaction, and in this area there are many examples of students being supported in the effective self-exploration of educational hypertexts by navigational prompts and tips embedded within the material (Veenman et al, 1994; Relan & Smith, 1996; Kashihar et al, 1999). Beyond this, it is thought that it may also help students to approach networked learning effectively if they are provided with information about why they are being presented with and asked to use particular resources, and what skills they will require to learn successfully in an online context (Sumner & Taylor, 1998; Collis & Meeuwsen, 1999). The former would take the form of precise statements about the purpose of various resources, for example indicating that interactive self-tests provide an opportunity to monitor understanding ahead of being formally assessed or that asynchronous discussion facilities provide a means for learning with the support of peers, while the latter kind of information would explain the need for good time management, evaluating progress, and how to manage difficulty.

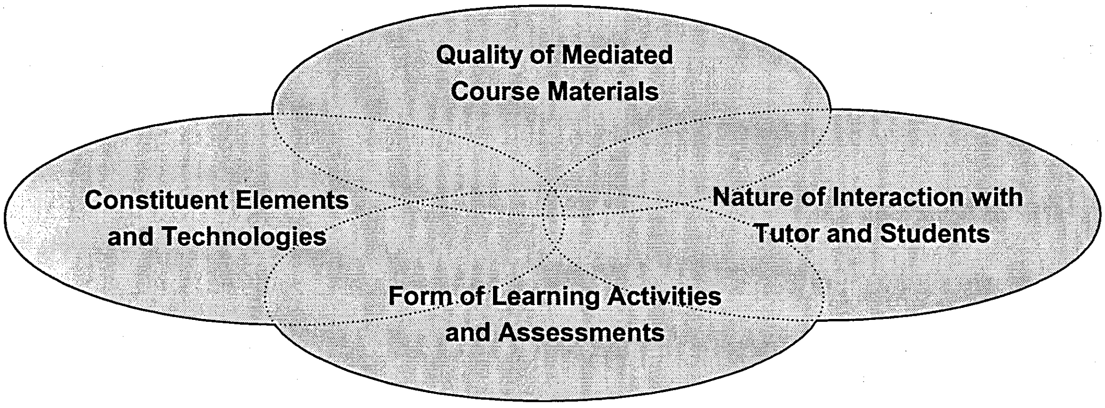


Figure 4: The Nature of the Networked Learning Environment

The students within the networked learning contexts investigated were not provided with this kind of explicit instruction, although it may well have proven beneficial, and especially to those who took a passive-autonomous approach that were fairly directionless in interacting with their NLEs and, unlike the constructive-autonomous students in particular, seemed not to posses a mindset conducive to learning online.

The course materials aside, in terms of the role other constituent elements of the environment might play (beyond possibly influencing mode of interaction), their main contribution to the nature of the NLE is through their quality and proliferation. The quality of constituent elements has obvious implications for their potential to support learning, and the central questions concern whether specific features are likely to aid or enhance learning in the ways intended, and whether they are easily operable. For example, the extent to which a supportive visual image effectively supports learning will partly come down to it being clear and easy to interpret, and partly be determined by the extent to which the content does accurately exemplify or elaborate upon what is described in the text it is intended to complement so that it does allow for effective dual coding. If the feature is of a more interactive nature, for example a discussion facility, self-test feature or simulation, then in addition to having appropriate content it must also be fairly easy to use or learn to use for the students in question, otherwise any educational benefits may be cancelled out. The chemical modeller in the chemistry NLE was felt to be difficult to use, and so any potential it might have had to support learning went unrealised for many. As regards their proliferation, then the more constituent elements there are the more potential opportunities for enhanced learning the environment will offer, and the richer the range of features is the more diverse the range of potential affordances becomes (e.g. multimedia for specific cognitive benefits, links to further reading for more elaborate exploration of the domain, asynchronous discussion for reflective debate and exposure to multiple perspectives). As seen, active-autonomous learners will interact selectively with many of the features at their disposal, and constructive-autonomous learners will interact fully with most if not all of them, so there are grounds for assuming a diverse range of features would prove beneficial.

Regarding the issue of interaction with tutors and students, based on the literature and the empirical element of this investigation the main influencing factors seem to be whether there are opportunities for interaction, and what form this takes. Although some of the students, mainly those who were constructive-autonomous in their approach, felt that they could manage without interacting with their fellow students, in general very few students did not feel that this was desirable wherever possible. At a minimum it was thought that it would be useful for confirming and possibly extending understanding of the topics under study, whereas a number of students, mostly those who exhibited a passive or active-autonomous approach, believed that this could make networked learning a less isolating experience. In addition, there was evidence to suggest that passive-autonomous networked learners tended to rely particularly heavily on interacting with their peers to gauge their progress and motivate them to work in normal course contexts, and would have been particularly welcoming of any increased opportunities for peer interaction in the networked learning they had undertaken. As a consequence, many individuals felt quite negatively about the relative lack, or in some cases absence, of student-student interaction in their networked learning contexts.

Where interaction with the tutor was concerned, unsurprisingly no one felt they could do without this, and all viewed it as an essential part of their learning whether online or not. As for the form this might take in a networked learning context, opinions varied. With their self-governing ability, and like of networked learning, constructive-autonomous individuals felt at ease with the idea of communicating with their tutors entirely via e-mail and discussion facilities as and when required. However with their respective needs for structure and guidance in order to learn effectively, it is clear that good provision for regular and on-demand communication from and with the tutor is essential for passive-autonomous and active-autonomous networked learners. For the students of the former type any communication from the tutor would arguably need to be explicit and possibly even quite didactic in nature, given their stated requirement for direct instruction on what they need to do by when. Students of the latter type valued elaborated explanations on topics and what was important in undertaking formal assignments, coupled with the opportunity to ask questions which would result in this kind of feedback, and so any communication from the tutor would arguably need to be of a supportive nature in these respects. In reality of course the implication is that the tutor, in dealing with a diverse range of students in networked learning contexts, would need to be both explicit and supportive in communicating both with the group online and, unless the type of feedback required is obvious, in conversing with individual students online. Yet online communication with the tutor, even where any communication received from the tutor is appropriate in content, may not in itself be enough for many networked learners. There are many subject areas that do not lend themselves to fully online learning and tutorial support, for example any that require practical skills to be acquired and refined, but this issue asides it is clear that for many students the need for regular interaction with the tutor also reflected a perceived need for interpersonal interaction. For the passive-autonomous learners identified, this was mainly associated with their desire to have the course subject area and the requirements of the associated work explained to them, along with the motivation that having classes at set times provided them with for actually progressing through their course. For the active-autonomous students identified, it was principally associated with being able to seek immediate clarification on issues, and picking up on the subtle or more direct aural clues regarding key topics and assessed work that the tutor might impart verbally.

The question of whether in practice increased interpersonal interaction with their tutors would have helped the passive and active-autonomous students learn more effectively is almost irrelevant, as although the suggestion is that it may well have, it would almost definitely have ensured that these learners, and the passive-autonomous individuals in particular, felt more at ease with and confident about otherwise learning predominantly online. However what is also certain is that where interaction with the tutor is to occur online, either on an individual or group basis, then the tutor must be an active and responsive participant in this. The literature is clear on the importance of this to effective online communication, stressing the need for the tutor to provide clear guidance to students on the purpose and participation requirements for asynchronous discussion, be responsible for initiating and subsequently facilitating conferencing activity, and responding in a timely and constructive manner to questions received via a discussion facility or e-mail (Hiltz, 1994; Berge, 1995; Harasim et al, 1995). Although the students involved in this investigation were largely positive about the speed and content of the e-mail responses received from their tutors on the few occasions when e-mail was used to seek guidance, dissatisfaction about the role of the tutor in the former respects had negative implications for some of the students. As a cohort the chemistry students had noted the lack of information their tutor had provided them with regarding the point of and requirements for using the discussion facility featured in their NLE, and as noted this discouraged at least some seemingly willing students from contributing to it. In addition, a number also felt that the tutor did not do enough in terms of encouraging participation in asynchronous discussion once the module had commenced. Some had interpreted their perceived absence of the tutor online as a sign that conversing about the subject matter online was not being regarded as a particularly important aspect of the module. This was despite the absence of traditional seminars

The students in the experiment, and to a slightly lesser extent those on the human factors module, also felt their tutors could have been more active participants in online discussion. Specifically, it was felt that they could have done more to guide the learning of the students by asking previously unconsidered questions, suggesting other relevant issues, and confirming where good progress was being made. The lack or relative lack of guidance of this type resulted in some learners feeling uncertain about just how well they understood aspects of the subject area under study. In this respect it was apparent from the accounts provided that the opinions of the tutor were seen as being more authoritative than those of fellow students, due to both the perceived expertise of the tutor and their role in assessing coursework, and as such they were more highly valued as an indicator of progress and source of support. Whilst this finding is not new (Wilson & Whitelock, 1998; Jones, 1999), in considering the networked learning approaches identified it seems reasonable to suggest that although the active involvement of tutors in online discussion should be beneficial all round, for the above reasons of perceived authority it is more likely to aid and be appreciated by passive-autonomous learners, with their need for explicit support, and active-autonomous learners with their desire for guidance (especially where assessed work is concerned).

The final factor that contributes towards the nature of the environment itself are the formal and assessed activities that the student is required to undertake. The constructivist literature suggests learning tasks and activities, including assessed work, are most effective when they require students to develop and apply knowledge in ways that reflect the real-world environment for which they are preparing, and proposes that traditional assessed activities like essays and exams encourage fairly linear, core-content based studying that is not best suited to learning in resource-rich constructivist educational environments (e.g. Shavelson & Baxter, 1992; Reeves & Okey, 1996; Jonassen, 1999). This is consistent with the view that in networked learning contexts good activities should provide students with a rationale and focus for interacting with their NLEs, and so essentially drive the networked learning process (Goodyear, 2002).

The findings of this research concurred with the view that authentic activities are more obviously conducive to effective networked learning whilst also offering some additional insight, and on this basis the proposed framework contends that networked learning activities should ideally be not just authentic in their content, but also periodic in their frequency in addition to being formally assessed. In the context of the experimental study and the human factors module, the problem, case and issue-based activities that were variously undertaken were viewed more favourably than summative essays and exams in terms of learning effectiveness and outcomes. Also, because different activities required different materials and tools within the environment to be utilised, many students saw the activities as a good way of encouraging a broad usage of the resources on offer rather than utilising only the core course notes and materials.

A defining trait of those taking a passive-autonomous approach was accessing the networked environment to study the material or undertake an activity immediately prior to a test or activity being due for completion. This conforms to previous research finding that under autonomous networked learning conditions many students will only engage with online resources when formal course deadlines are upon them (Taraban et al, 1999; Smeaton & Keogh, 1999). Yet whilst this should be accepted, with the activities undertaken by the experimental and human factors students being periodic in that their deadlines were staggered throughout the respective modules, it was felt that this had encouraged a more consistent networked learning effort than may have otherwise occurred. Many students conceded that if they only had a single essay or exam to submit or complete at the end of the module then they probably would have began studying via their environment nearer this time rather than throughout from the outset. The clear implication here, particularly for passive-autonomous networked learners, is that whilst some individuals will undoubtedly undertake networked learning in a last minute manner, having periodic rather than summative activities at least ensures there is some continued interaction with networked environments over time through multiple instances of last minute studying. Furthermore if the activities undertaken periodically require different materials and tools to be utilised in their completion, then even those students who interact in a fairly minimal way with the resources at their disposal will have at least interacted to some degree with a diverse range of them, rather than simply concentrating their efforts on core materials alone.

Finally, in terms of being formally assessed then both the existing literature and this investigation concur that this a major influence on what most students will perceive as "legitimate" networked learning activity, and will therefore undertake with more effort than they would, if at all, on a voluntary basis (McAteer et al, 1997; Laurillard, 2002). This was most obvious in the context of the chemistry module, where two-thirds agreed that they would have participated in online discussions if they had been assessed for doing so, while at a broader level of networked learning activity all of the chemistry students indicated that they would have used their environment more extensively if they had been directly assessed on the work done within it. Regardless of the approach to networked learning a student is likely to take then, it could become more pro-active both overall and in relation to a specific aspect of networked learning depending upon whether they are being formally assessed for it. In relation to specific approach types, in respectively trying to cope with the minimum requirements of a networked course or focusing on the assessed components of it, the implication for those who will take either a passive-autonomous or active-autonomous approach to networked learning is that their efforts may be most effectively supported by being formally assessed on as many key aspects of networked learning as is possible within the context of a specific course, and being made aware of this in the course objectives that are communicated to them.

Finally, the proposed framework suggests that a key proviso to networked learning activities being effective through being authentic, periodic and assessed is that they must be appropriate to networked learning generally, or some aspect of it. As regards the former, it is proposed that this is determined by the extent to which activities can be considered authentic in the context of a particular module, and whether they are also periodic and assessed. Appropriateness in relation to a specific aspect of networked learning is a different consideration, and depends upon whether what the learners are being asked to do using a specific resource is feasible. One example might be whether the case study materials provided online covers the full range of factors that a report on that particular case scenario, whatever it may be, is expected to address. Within the human factors module, the students felt their asynchronous discussion facility was not wholly effective for the responsive decision-making and collaborative authoring it was intended to support fully online, and as a result much collaboration occurred offline.

7.6 COMPARISON WITH RELEVANT ESTABLISHED FRAMEWORKS

The relevant literature offers several examples of what are positioned as, or can be described as, either theoretical frameworks or theory-based models for addressing and understanding aspects of student learning and instructional practice in relation to learning environments and educational technology. In the constructivist tradition, Grabinger & Dunlap (1995, Dunlap & Grabinger, 1996) describe the characteristics of what they define as Real Environments for Active Learning (REALs). In doing so they present the key assumptions of constructivist learning theory such as student responsibility, authentic contexts and collaboration, before exploring how these can be instantiated within the instructional environment. As an extension to this largely descriptive framework they also explain, with examples of practice, how the principles of REALs can be applied in relation to problem-based learning. Similarly, Savery & Duffy (1996) present what they describe as "an instructional model and its constructivist framework" (p. 135) for problem-based learning. Again the focus is on how constructivist principles can be adapted to this particular method, and instructional recommendations for learning goals, problem generation and presentation, and the role of the tutor are offered. At a broader level of practice, but deeper level of theoretical consideration, Hannafin et al (1997) examine the psychological, pedagogical and other foundations for informing the design of learning environments, and describe how to take a grounded approach to designing constructivist learning environments to ensure that foundational assumptions and instructional methods are effectively aligned.

Still in the constructivist vein, but with a specific focus on technology, Hannafin & Land (1997) have complemented the above framework by exploring the foundations and assumptions of "technology-enhanced student-centred learning environments" (p. 168). In doing so they look with examples at how emerging technologies including the web and other integrated media platforms can support meaningful individual and social cognition, and provide some general pointers and guidelines. The effective use of integrated media is also the concern of an earlier theoretical framework developed by the Cognition and Technology Group at Vanderbilt (CTGV, 1993), and which is perhaps more indicative of possible instructional practice through detailing the rationale behind, and implementation of, several integrated media environments for varying instructional purposes. In more of a cognitive science research tradition, Najjar's (1997) framework for learning from multimedia takes a critical overview of previous research to outline a theoretical framework that takes more account of the learners, the materials, the tasks performed and the tests to be undertaken in determining the conditions under which educational multimedia is likely to prove most effective.

Finally, in the phenomenographic tradition Entwistle (1987, 2003a, 2003b) presents several models of the teaching-learning process that are based on the results of several major investigations into the nature of learning in higher education, including most recently his work with colleagues on the ETL (Enhancing Teaching-Learning Environments in Undergraduate Courses) project (Entwistle, 2003a, 2003b). The key components of these models including approaches to studying, learning context, and teaching characteristics are described, and the likely relationships amongst them considered. These factors are represented diagrammatically in the models themselves, which are intended to be heuristic devices that summarise the relevant research findings, provide a starting point for lecturers who want to consider the effects of their teaching practices upon students with different learning traits and characteristics, and which could guide future research into the teaching-learning process. The work presented in Entwistle (2003b) is particularly noteworthy. This presents a series of related models addressing the key influences on the student approach, ways of thinking within the given field, and the factors that influence the 'inner' teaching and learning environment (p. 1-7). More recently in the phenomenographic tradition, Berglund (2004) has combined phenomenography with concepts from activity theory to produce a framework for understanding collaborative learning in distributed online environments.

The framework proposed by this investigation is at the initial stage of development, and in this respect is an attempt to move beyond the main findings of the research to present an informed overview perspective on the nature of autonomous networked learning, and the interplay between the individual and the extrinsic factors that influence it. Although the proposed framework was received positively on initial dissemination (Smyth & Buckner, 2004), a fuller development would require further research. Yet in contrasting it with the above examples it is apparent that it is closest in nature to Entwistle's (1987, 2003a, 2003b) models and accompanying explanations of the teaching-learning process. This is to be expected given that both Entwistle's models and the one proposed here are derived from phenomenographic research into the student experience of learning, and although both models are underpinned by specific theoretical beliefs about what learning is and how it occurs within the contexts they address, their content is based on an interpretative analysis of subjective student accounts of their learning experiences.

For this reason the proposed framework is primarily a descriptive one, which is something unlikely to change through future refinement, as this is arguably the form most appropriate to the research that underpins it. In this respect it is quite different from the various constructivist frameworks and models cited as examples, all of which are primarily prescriptive as they essentially distil theoretical beliefs and assumptions about the nature of learning into a set of practical rules or principles that are more readily applicable to designing educational environments, and facilitating learning within them.

7.7 PRACTICAL APPLICATIONS AND RESEARCH IMPLICATIONS

Given the descriptive nature of the proposed framework, any practical or research implications that arise from it being more fully developed and disseminated are likely to rest on the insight it might offer into the range of factors, and the relationships between them, that influence the manner in which autonomous networked learning is undertaken and the extent to which it proves educationally effective. In terms of being developed for wider use, the proposed framework would account more fully for the assumptions about learning and networked learning that underpin it, what is currently understood from previous research, and most importantly provide full descriptions of the approach types identified and the extrinsic factors that were seen to affect how students undertook networked learning. In the context of this thesis, which had already addressed these issues in previous chapters, presenting a fully developed framework rather than outlining the basic content for one would have proven problematic in this respect.

In describing the factors that can be seen to influence the nature of autonomous networked learning from a student perspective, on a practical level it is envisaged that the framework could have some worth to tutors or course designers who want to reflect on their current or planned use of networked learning environments, and consider the range of issues that might impact, or be impacting, upon how effectively their students undertake or are undertaking autonomous networked learning. This may lead to a more informed design of networked resources and approach to supporting their students in online contexts on the part of the tutor, and may also increase awareness of the areas in which current partially or fully online courses could be further improved for future delivery. For research purposes, then the framework may be of value in simply highlighting aspects of networked learning that are worth further investigation. This could include the idea of networked learning styles or approaches and their implications, or the influence features of NLEs might have upon how students interact with them. Alternatively, it may act as tool by which to consider possible explanations for findings from investigations into networked learning interactions and outcomes.

These possible uses for the proposed framework are comparable to those for the heuristic models that Entwistle (1987; 2003a) based on his explanation of the teaching-learning process in conventional higher education, which again is probably reflective of the phenomenographic research approach from which all are derived. In a similarly comparable manner, it could also be that the application of the proposed framework for teaching and research purposes might be more effectively aided through the depiction of the factors and inter-factor relationships that it describes in a diagrammatic format.

A model based on the content of the proposed framework is illustrated on page 320 (Figure 5: The Nature of Autonomous Networked Learning – A Diagrammatic Overview). This model depicts the central three-factor relationship between individual approaches, the networked learning environment, and mode of interaction with the environment that was seen to determine the nature and effectiveness of the autonomous networked learning experience. It also accounts for the various factors that themselves influence whether an individual takes a passive-autonomous, active-autonomous or constructive-autonomous approach to networked learning, the time spent interacting with the environment and whether this is on or offline, and the nature of the NLE itself and the potential for supporting effective networked learning that is inherent within it.

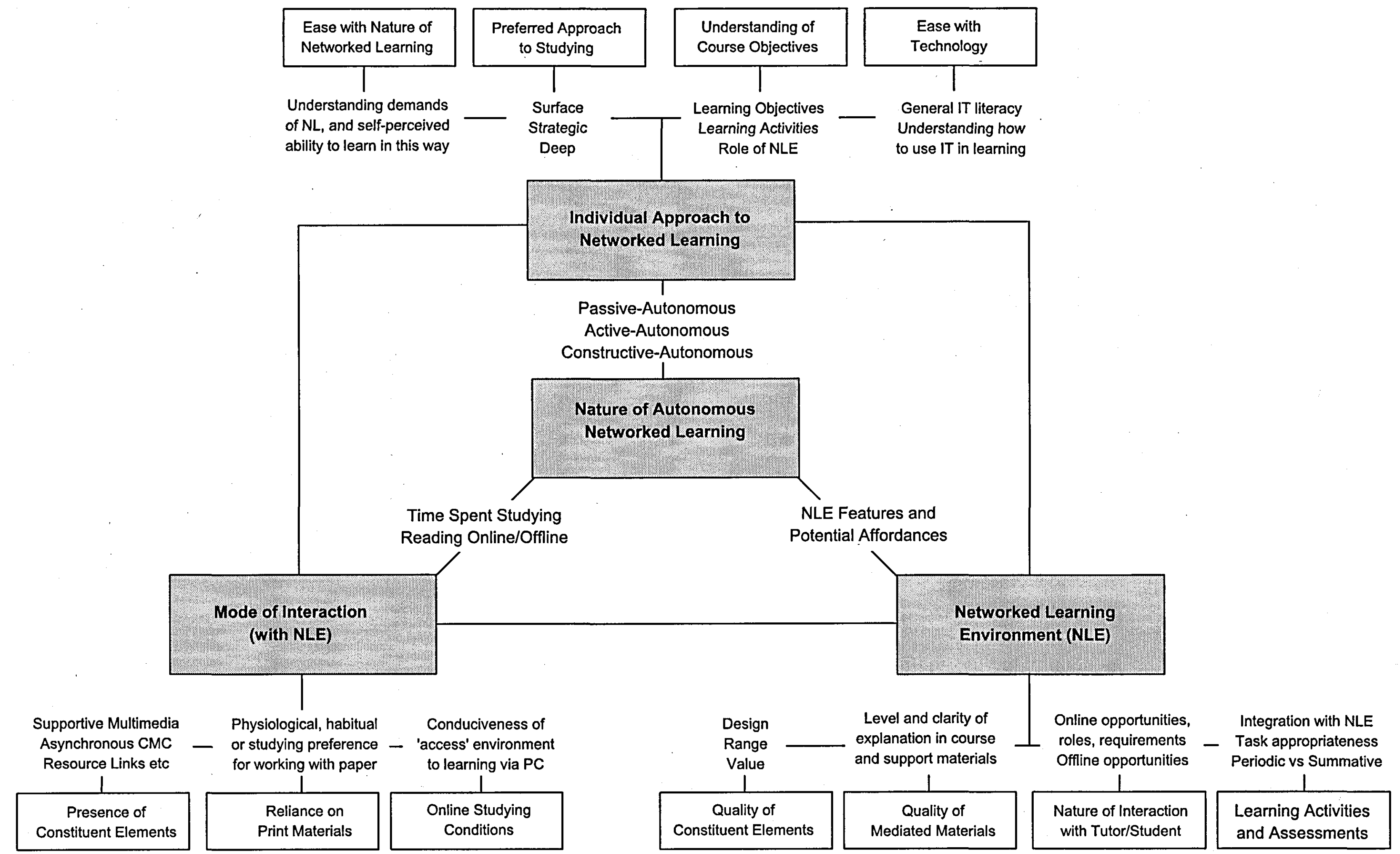


Figure 5: The Nature of Autonomous Networked Learning - A Diagrammatic Model of Key Factors in The Student Experience

Although the model itself can only provide an overview of the individual and extrinsic influences that can be seen to shape the networked learning experience for students, whilst the proposed framework with which it is associated is primarily descriptive rather than prescriptive in nature, the model itself could nevertheless be used to an extent in a prescriptive manner by tutors and course designers. For example, in seeking to ensure that all their students approach networked learning as effectively as possible, a tutor might look to the model and question the extent to which their students are equipped to study online, whether their learning objectives and explanation of course networked learning requirements are clear, the appropriateness of core subject materials in terms of clarity and depth, if the activities the students are required to undertake are likely to effectively engage them with the NLE over time, and whether the environment is likely to support learning in a diverse range of ways through the presence of asynchronous discussion facilities, good visual multimedia and other knowledge-enhancing features.

Of course any such model, like the accompanying proposed framework, would have to be accepted on the basis that it is the result of a rigorous but nevertheless small-scale investigation. For this reason further research into the factors that the framework and model address, and subsequent refinement of the framework and model themselves, would be necessary. However in the apparent absence of any comparable research into the nature of autonomous networked learning at a time when the practice of supporting students online continues to increase, then a framework and model of the kind described could perhaps prove a valuable aid to more informed research and practice in this area.

8.0 CONCLUSIONS AND RESEARCH RECOMMENDATIONS

In seeking to understand the nature and effectiveness with which students interact with autonomously accessible networked learning environments, this investigation found evidence to suggest it is possible to differentiate between three types of approach to networked learning. The findings indicated that the approach taken was the primary influence upon the extent to which students interacted with NLEs in a manner conducive to benefiting from the affordances thought to be inherent within them, and the quality of the resulting networked learning outcomes. In addition the investigation highlighted the influence that various instructional factors, including the features of the environment itself, had upon how students undertook and perceived networked learning, and proposed that the nature of autonomous networked learning could be seen an inter-relationship between individual approach-, NLE-, and instructional-related influences.

In conclusion this thesis now considers the reliability, validity and implications of the main findings, and the possible directions for the continuation of the research reported.

8.1 RELIABILITY AND VALIDITY OF FINDINGS

Generally, the reliability of research is seen to depend upon whether the methods used could produce similar results in a similar context, whilst validity is judged on the extent to which the methods used can be said to have actually measured or related to the issues being explored (Blaxter et al, 2001, p. 221). Yet the acceptance of subjectivity and reliance on subjective descriptions that characterises interpretative social science can make these concepts difficult to apply in judging the integrity of qualitative research (Erlandson et al, 1993; Mason, 1996). Certainly it would be difficult to say whether another researcher using phenomenography as the principle method to investigate how students undertake networked learning would produce findings comparable to this investigation, or conceptualise the apparent nature of approaches to networked learning in a broadly similar way. Indeed, the danger of producing descriptions of experience that are meaningful only to the researcher is one of the main criticisms of phenomenographic research (Ashworth & Lucas, 1998; Myer, 1988, Richardson, 1999).

However it has been suggested that rather than the potential reliability of qualitative research being determined through the application of the same methods in similar contexts, it is more appropriate to consider whether complementary methods were used and produced consistent findings by the research in question (Mason, 1996). This has also been acknowledged as useful means by which the interpretations of subjective experience presented within phenomenographic research can be seen as dependable (Richardson, 1999). This investigation arrived at an understanding of the different approaches taken to networked learning through phenomenographic data collection and analysis procedures, and on this basis judged that the passive-autonomous, active-autonomous and constructive-autonomous approaches identified were, in this order of progression, associated with increasingly effective networked learning. This was verified through triangulated data collection, with the quantitative usage logs and post-experience questionnaires indicating that the respective approaches conceptualised had in practice been associated with more frequent and extensive interaction with NLEs, and qualitatively better learning outcomes, on a passive-through-constructive continuum.

In terms of general validity, then the coherence between subject and method outlined in 3.6 at least ensured that what was being investigated and how it was being investigated were consistent with one another. Regarding the approaches to networked learning classification scheme that was devised, a potentially relevant issue is the 'construct validity' of this taxonomy. Although this concept is associated with quantitative-based social science research, it may have a particular relevance for this investigation. Richardson (1990) used a construct validity measurement to determine the extent to which the Approaches to Studying Inventory did actually provide "direct information about the approaches to learning that are adopted by students" (p. 165). Adopting this basic idea, a pertinent question on the validity of this research concerns whether the classification scheme did accurately correspond to the limited number of different ways in which students undertook networked learning. The relative ease with which the scheme could be applied in determining the approach of most individuals would seem to indicate that it was fairly true to the descriptions of experience provided by the students, whilst the fact the students themselves were drawn from three quite different networked learning research contexts further suggests that the respective approach classifications were relating to something quite fundamental. Erlandson et al (1993) suggest that the descriptive validity of an interpretative analysis can be confirmed through asking the research participants if it represents a credible account of their experiences. Whilst this was not possible in this investigation, as noted in the results chapters the correlation between approach classifications and data on patterns of interaction and outcomes suggests that the scheme certainly has at least a moderate degree of descriptive worth.

8.2 GENERAL IMPLICATIONS FOR THE FIELD

In considering what implications the findings of this research might have for the field of networked learning, and technology-based learning generally, there are a number of potentially relevant points that can be made in relation to practice, research and theory.

Addressing practise first, as outlined in the previous chapter it is hoped that the proposed theoretical framework and associated model may be of some relevance to educators planning to use networked learning in their own teaching. By highlighting the primary factors that influence the nature and effectiveness of networked learning for students, and the interrelationships between them, the key value of the framework could be in leading to a more informed design of networked environments and support that maximises the educational potential of learning in this way for all the students in a cohort, and not just those who are amongst the more independent and pro-active.

This investigation focused on networked learning contexts that were campus-based, and that featured NLEs as the sole or primary method of course delivery for individual modules. However it could be that the findings of the research could aid practice within other networked and technology-based learning contexts. On a broader scale the main content of the proposed framework – including the emphasis on clear course objectives, the influence of learner characteristics, explicit instructional guidance, authentic and periodic formal activities, the role of the tutor, and a rich range of diverse NLE features – could reasonably be applied to networked learning contexts in which entire programmes, or a significant part of them, are delivered online. On a smaller scale, then factors like clear learning objectives, purposeful activities, and explicit guidance to aid interaction could also apply to the use of specific resources, e.g. asynchronous discussion or stand-alone hypertext-based environments, in campus-based contexts.

The previous chapter also addressed the potential value of the findings for informing research into aspects of autonomous networked learning, perhaps including those that have received little attention to date, or simply providing a means by which possible explanations for empirical observations can be identified. As with the area of practice, it hoped that the main findings of this investigation could also be generalised to other areas of research, including understanding student networked learning behaviours and experiences in both distance and combined lecture/online campus-based contexts.

There is still much to be understood in terms of how students undertake networked learning, and the findings of this investigation indicate that research to date has been limited in important respects. To recap, the lack of insight into the relationship between learning styles and interaction with networked and other technology-based environments of previous studies, and their often inconsistent findings, would seem to have been hindered by the use of quantitative tools designed to assess learner preferences and characteristics as they relate to general contexts and conventional courses. The findings of the phenomenographic element of this research indicate that students can indeed be said to undertake networked learning in ways that are consistent with the notion of them exhibiting particular styles or approaches. Furthermore whilst these were comparable in basic essence to preferred approaches to traditional studying, they did represent different ways of negotiating understanding in autonomous networked learning contexts, and were the major influence upon networked learning outcomes. The implication for research into learning styles and educational technology then is that it might be more worthwhile and insightful to focus directly on what students do when interacting with technology, and why, rather than trying to understand the reasons for their interactions solely through using tools designed for other purposes.

However much of the research that has been concerned with the experiential aspects of networked and technology-based learning has itself been problematic, as an over-reliance on survey-based research at the expense of in-depth qualitative investigation has resulted in only a fairly basic understanding of what students like and dislike about networked learning, and see as the main ways in which it is educationally beneficial. Furthermore, it may be misleading to take students perceptions of networked learning benefits as an indication that the potential affordances inherent within NLEs have actually been realised and successfully supported cognition. As the findings of this investigation demonstrated, whilst many students will show an awareness of the possible benefits of networked learning, in looking at the type of approach taken it becomes immediately apparent that far fewer actually interact with NLEs in ways that are conducive to the successful exploitation of the range of affordances they offer.

Whilst this may indicate a general problem with research that starts and stops with establishing basic student perceptions of educational technology, and then uses this as a basis for making positive claims about it, the implications for current theory are also significant. Clearly, there has to be a shift in thinking concerning the notions of affordances as it is generally applied to educational technology. The current conception is essentially of affordances as properties of specific educational technologies that will support or extend the cognitive ability of the learner as they interact with them. This is arguably a misconception if the approach the individual takes to interacting with technology is accepted as having a direct influence upon the nature and effectiveness of their interactions. Instead, it is probably more appropriate to view the affordances of educational technology as opportunities for enhanced cognition that have the most potential to support individuals who utilise the technology in effective and purposeful ways. This is closer in nature to Gibson's (1977, 1979) conception of an affordance as a relationship that exists between an individual and the opportunities for action within an object in their environment, and which emerges when the individual has a reason for or need to use that object. Gibson also explained that affordances can be both positive and negative in their nature, and what we currently understand about the nature of networked learning affordances could be enhanced if it is more widely recognised that for some students many of the opportunities for self-paced interaction with a diverse range of resources may be largely negated if the student does not feel suited to or equipped for networked learning, or aspects of it, or exploits the opportunity for autonomous learning negatively to procrastinate and repeatedly delay studying. Work on intelligent tutoring systems has begun to address the idea of affordances as emergent properties of the relationship between the individual and technology (Akhras & Self, 2002; Young et al, 2002), but only a few constructivist theorists writing about the benefits of educational technology have acknowledged this (e.g. Salomon, 1986; Land & Hannafin, 2000). The latter recognise that "while tools or resources may *afford* an opportunity for cognitive processing, they may or may not be used mindfully by the learner to extend thinking or understanding" (Ibid, p. 187). On the evidence of this investigation it seems there is a need for other theorists and practitioners to follow suit.

8.3 CONTRIBUTION TO KNOWLEDGE

Beyond adding to the relatively small amount of related qualitative research, this thesis makes two principal contributions to the current body of knowledge. One is in offering what may be the first, or among the first, conceptualisations of networked learning styles or approaches directly informed by original research. The second is in producing a related theoretical framework, and associated model, that is based upon the student experience of networked learning, and which attempts to further our understanding of the relationship between the learner, the NLE, and networked learning outcomes.

8.4 EMERGING WORK

The writing of this thesis was originally completed in Spring 2004. At the time of the thesis being prepared for submission and examination, work in the general area of networked learning and individual differences has continued apace. Current work includes that by Sadler-Smith & Smith (2005) on strategies for accommodating individual learning styles in flexible, online-supported programmes, and the research of Lo & Shu (2005) in identifying learning styles through online browsing patterns. While this recent revisiting of the literature confirms that new work in this area continues, the focus remains very much on quantitative research, and using existing ideas about learning styles that may be limited in really explaining online learning behaviour.

In the current climate of emerging social software, the opportunities for students to learn beyond the confines of their traditional and virtual classrooms by engaging in wider online learning communities through tools such as Blogs and Wikis is an area in which a new wave of research in the field looks promising (Wenger, 2005). Although this thesis focused on the individual and their experience of networked learning, this suggests that similar research into the student experience would be wise to focus on their social interaction with one another both within and beyond the immediate NLE.

8.5 DIRECTIONS FOR FUTURE RESEARCH

Regarding the continuation of the work presented herein, there are a number of directions that this could take. Further research into the networked learning approach types identified would be the obvious priority. This would establish their wider applicability, and also help in refining the initial understanding of them that this investigation offers. As noted, the area in which the classification scheme is most limited is in how the active-autonomous approach is conceptualised, as in applying the scheme to determine the approaches of individuals it was apparent that a minority classified as active-autonomous veered towards passive-autonomous in some respects.

Continued investigation could also seek to establish whether networked learning approaches are developmental and subject to change over time. The likelihood is that they may well be, given that defining features of the passive-autonomous approach included a perceived a need for tutor-led studying conditions, and negative feelings about networked learning that seemed to focus not on what networked learning offered, but how it differed from traditional lecture-based courses. Many of the students who participated in the research, almost all of whom were new to learning entirely online, did actually indicate that they could become more accustomed to networked learning over time. As the framework suggested in places, there are some grounds for assuming that good online course design may help to influence the approaches students take to networked learning, and particularly in ensuring that those who might otherwise take a passive-autonomous approach may be encouraged to be more effective online learners.

Although a full exploration of these important issues fell out with the main focus of this research, an empirical focus on the development of networked learning skills and approaches, and how this can be facilitated, would certainly be worthwhile.

In addition, further research into the issue of networked learning approaches might attempt to understand more about their apparent relationship with approaches to conventional studying. It could be that the passive, active and constructive-autonomous approaches identified may be more appropriately termed surface, strategic and deep approaches to networked learning, given the basic concern with either coping, achieving or understanding that the comparable passive-surface, active-strategic, constructive-deep approach pairs respectively seem to share. Another obvious continuation of the research would be to operationalise the classification scheme in the form of a 'approaches to networked learning' inventory comparable to the ASI, although whilst this direction for the research seems like a logical progression, exactly what purpose any such inventory would serve is less clear. Perhaps it could help facilitate small-scale research into the effects of networked learning approaches or styles in relation to specific issues and questions, and where a significant qualitative research element would be impractical (i.e. in distance contexts) or time consuming. Such an inventory may at least present an alternative to using tools that relate to learning in more general contexts to assess how individual differences impact upon student use of technology.

Finally, the influence of the environment itself, and other extrinsic factors, upon the nature and effectiveness of networked learning is also worth exploration. In the context of the naturalistic experiment it seemed that the presence of certain features within the NLE, particularly visual and interactive supportive multimedia, had encouraged more online studying activity than occurred amongst groups who were interacting with predominantly text-based environments. As established, this has certain implications for encouraging online learning and ensuring that students interact with a range of the resources at their disposal. There was also some evidence, admittedly limited, that the most effective networked learners in terms of outcomes were constructive-autonomous learners with access to the most resource-rich environments. Furthermore, across all three research contexts it was apparent that few students studied exclusively offline, and that when many did it was due the perceived limitations of studying via NLEs, for example the inability to annotate materials. This suggests that the practice of working with paper-based copies of networked material is not always as negative, or mutually exclusive to studying online, as it is often portrayed to be. All of these issues arguably require further investigation in order to benefit our practice and understanding.

9.0 REFERENCES

Abbey, B. (Ed.) (2000). *Instructional and cognitive impacts of web-based education.* London: Idea Group Publishing.

Adrianson, L. & Hjelmquist, E. (1999). Group processes in solving two problems: face-to-face and computer-mediated communication behaviour. *Behaviour and Information Technology, 18*(3), 179-198.

Akhras, F.N. & Self, J.A. (2002). Beyond intelligent tutoring systems: situations, interactions, processes and affordances. *Instructional Science, 30*(1), 1-30.

Alleman, J. & Brophy, J. (1998). *Assessment in a social constructivist classroom. Social Education, 62*(1), 32-34.

Allen, B.S., Chiero, R.T., & Hoffman, R.P. (1996). Mapping more authentic multimedia learning environments. In B.G. Wilson (Ed.), *Constructivist learning environments: case studies in instructional design* (pp. 179-190). Englewood Cliffs, New Jersey: Educational Technology Publications.

Alessi, S.M. & Trollip, S.R. (2001). *Multimedia for learning: methods and development* (3rd edition). Allyn and Bacon.

Allinson, L. (1992). Learning styles and computer-based learning environments. In I. Tomek (Ed.*), Computer-assisted learning: lecture notes in computer science (volume 602)* (pp. 61-73). Berlin: Springer-Verlag.

Anderson, J.R. (1995). *Learning and memory: an integrated approach.* New York: John Wiley.

Anderson, J.R. (1990). *Cognitive psychology and its implications* (3rd ed.). New York: W.H. Freeman.

Anderson, J.R., Reder, L.M., & Simon, H.A. (1996). Situated learning and education. *Educational Researcher, 25*(4), 5-11.

Angeli, C., Valanides, N. & Bonk, C. (2003). Communication in a web-based conferencing system: the quality of computer-mediated interactions. *British Journal of Educational Technology, 34*(1), 31-43.

Angulo, A.J. & Bruce, M. (1999). Student perceptions of supplemental web-based instruction. *Innovative Higher Education, 24*(2), 105-125.

Ashworth, P. & Lucas, U. (1998). What is the world of phenomenography? *Scandanavian Journal of Educational Research, 42*(2), 415-431.

Atkinson, R.C. & Shiffren, R.M. (1968). Human memory: a proposed system and its control processes. In K.W. Spence & J.T. Spence (Eds.), *The psychology of learning and motivation: advances in research and theory volume 2* (pp. 89-195). New York: Academic Press.

Ausubel, D.P. (1968). *Educational psychology: a cognitive view*. New York: Holt, Rinehart and Winston.

Ausubel, D.P. (1963). *The psychology of meaningful verbal learning: an introduction to school learning*. New York: Grune and Stratton.

Azevedo, R. (2002). Beyond intelligent tutoring systems: using computers as metacognitive tools to enhance learning? *Instructional Science, 30*(1), 31-45.

Barab, S.A. & Duffy, T.M. (2000). From practice fields to communities of practice. In *Theoretical foundations of learning environments* (pp.25-56), D.H. Jonassen and S.M. Land (Eds). Lawrence Erlbaum.

Baugher, D., Varanelli, A. & Weisbord, E. (2003). Student hits in an internet-supported course: how can course instructors use them and what do they mean? *Decision Sciences Journal of Innovative Education, 1*(2), 159-179.

Baur, M.I. & Johnson-Laird, P.N. (1993). How diagrams can improve reasoning. *Psychological Science, 4*(6), 372-378.

Beasley, N. and Smyth, K. (2004). Expected and actual student use of an online learning environment: a critical analysis. *EJEL*, 2(1). Online at: http://www.ejel.org/index.htm.

Becker, D. & Dwyer, M. (1994). Using hypermedia to provide learner control. *Journal of Educational Multimedia and Hypermedia, 3*(2), 155-172.

Bednar, A.K., Cunningham, D., Duffy, T.M. & Perry, D.J. (1992). Theory into practice: how do we link? In T.M. Duffy & D.H. Jonassen (Eds.), *Constructivism and the technology of instruction* (pp. 17-34). New Jersey: Lawrence Erlbaum.

Bednar, A.K., Cunningham, D., Duffy, T.M. & Perry, J.D. (1995). Theory into practice: how do we link? In G.J. Anglin (Ed.), *Educational technology: past, present and future* (2nd ed.) (pp. 100-112). Englewood, Colorado: Libraries Unlimited.

Beeman, W.O., Anderson, K.T., Bader, G., Larkin, J., McClard, A.P., McQuillan, P. & Shields, M. (1987). Hypertext and pluralism: from lineal to non-lineal thinking. *Proceedings of the ACM Hypertext 87 Conference* (pp.67-88). ACM,

Bell, P. and Winn, W. (2000) "Distributed cognitions, by nature and design", In *Theoretical foundations of learning environments* (pp.123-144), D.H. Jonassen and S.M. Land (Eds). Lawrence Erlbaum.

Berge, Z.L. (1995). Facilitating computer conferencing: recommendations from the field. *Educational Technology*, January-February, 22-30.

Berge, Z.L., Collins, M. & Dougherty, K. (2000). Design guidelines for web-based courses. In B. Abbey (Ed.), *Instructional and cognitive impacts of web-based education* (pp. 32-40). London: Idea Group Publishing.

Berglund, A. (2004). A framework to study learning in a complex learning environment. *ALT-J, 12*(1), 65-80.

Bickman, L. & Rog, D.J. (Eds.) (1998). *Handbook of applied social research methods.* Thousand Oaks, California: Sage.

Biggs, J. (1996). Enhancing teaching through constructive alignment. *Higher Education, 32*, 347-364.

Biggs, J. B. (2003). *Teaching for quality learning at university* (2nd edition). Buckingham: The Society for Research into Higher Education & Open University Press.

Biggs, J.B. & Collis, K.F. (1984). *Evaluating the SOLO taxonomy (structure of the observed learning outcome)*. London: Academic Press.

Blaxter, L., Hughes, C. & Tight, M. (2001). *How to research* (2nd edition). Buckingham: Open University Press.

Bordia, P. (1997). Face-to-face versus computer-mediated communication: a synthesis of the experimental literature. *The Journal of Business Communication, 34*(1), 99-120.

Bostock, S.J. (1998). Constructivism in mass higher education: a case study. *British Journal of Educational Technology, 29*(3), 225-240.

Boud, D. (Ed.) (1985). *Problem-based learning in education for the professions*. Higher Education Research Society of Australasia.

Boud, D., & Feletti, G. (Eds.) (1991). *The challenge of problem based learning.* London: Kogan Page.

Boulton-Lewis, G. (1998). Applying the SOLO taxonomy to learning in higher education. In B. Dart & G. Boulton-Lewis (Eds.), *Teaching and learning in higher education* (pp. 201-221). Victoria: The Australian Council for Educational Research.

Boulton-Lewis, G., Marton, F., Lewis, D.C. & Wiles, L.A. (2000). Learning in formal and informal contexts: conceptions and strategies of Aboriginal and Torres Strait Islander university students. *Learning and instruction, 10*(5), 393-414.

Boulton-Lewis, G., Marton, F., Lewis, D.C. & Wiles, L.A. (2004). A longitudinal study of learning for a group of indigenous Australian university students: dissonant conceptions and strategies. *Higher Education, 47*(1), 91-112.

Bourne, J. R., McMaster, E., Rieger, J. & Campbell, J.O. (1997). Paradigms for on-line learning: a case study in the design and implementation of an asynchronous learning networks (ALN) course. *Journal of Asynchronous Learning Networks, 1*(2), 38-56.

Bowles, M.S. (2004). *Relearning to e-learn: strategies for electronic learning and knowledge.* Melbourne University Press.

Bransford, J.D., Sherwood, R.D., Hasselbring, T.S., Kinzer, C.K. & Williams, S.M. (1990). Anchored instruction: why we need it and how technology can help. In D. Nix & R. Spiro (Eds.), *Cognition, education, multimedia: exploring new ideas in high technology* (pp. 115-141). Hillside, New Jersey: Lawrence Erlbaum.

Brown, A. (1987). Metacognition, executive control, self-regulation, and other more mysterious mechanisms. In F.E. Weinert & R.H. Kluwe (Eds.), *Metacognition, motivation and understanding* (pp. 65-116). Hillside, New Jersey: Lawrence Erlbaum.

Brown, G., Bull, J. & Pendlebury, M. (1997). *Assessing student learning in higher education*. London: Routledge.

Brown, J.S., Collins, A. & Duguid, P. (1989). Situated cognition and the culture of learning. *Educational Researcher*, *18*(1), 32-42.

Bruner, J.S. (1961). The act of discovery. *Harvard Educational Review*, *31*(1), 21-32.

Bruner, J.S. (1974). *Beyond the information* given. London: George Allen and Unwin.

Buckner, K. & Morss, K. (1999). The importance of task appropriateness in computer-supported collaborative learning. *ALT-J*, *7*(1), 33-38.

Burne, J.R., McMaster, E., Rieger, J. & Campbell, J.O. (1997). Paradigms for on-line learning: a case study in the design and implementation of an asynchronous learning networks (ALN) course. *Journal of Asynchronous Learning Networks*, *1*(2), 38-56. Online: http://www.aln.org/index.htm.

Burton, J.K., Moore, D.M. & Holmes, G.A. (1995). Hypermedia concepts and research: an overview. *Computers in Human Behavior*, *11*(3/4), 345-369.

Bush, V. (1945). As we may think. *The Atlantic Monthly*. Online: http://www.theatlantic.com/unbound/flashbks/computer/bushf.htm.

Carswell, L., Thomas, P., Petre, M., Price, B. & Richards, M. (2000). Distance education via the internet: the student experience. *British Journal of Educational Technology, 31*(1), 29-46.

Casey, C. (1996). Incorporating cognitive apprenticeship in multimedia. *Educational Technology Research and Development*, *44*(1), 71-84.

Chambers, P. (1999). Information handling skills, cognition, and new technologies. *British Journal of Educational Psychology*, *30*(2), 151-162.

Chen, S.Y. & Ford, N.J. (1998). Modelling user navigation behaviours in a hypermedia-based learning system: an individual differences approach. *International Journal of Knowledge Organisation*, *25*(3), 67-78.

Chen, C. & Rada, R. (1996). Interacting with hypertext: a meta-analysis of experimental studies. *Human-Computer Interaction*, *11*, 125-156.

Cheng, P.C., Lowe, R.K. & Scaife, M. (2001). Cognitive science approaches to understanding diagrammatic representations. *Artificial Intelligence Review, 15*(1), 79-94.

Chuang, Y. (1999). Teaching in a multimedia computer environment: a study of the effects of learning style, gender, and math achievement. *Interactive Multimedia Electronic Journal of Computer-Enhanced Learning*, *1*(1). Online: http://imej.wfu/edu/.

Clark, J.M. & Paivio, A. (1991), Dual coding theory and education. *Educational Psychology Review, 3*(3), 149-210.

Clark, R.E. (1983). Reconsidering research on learning from media. Review of *Educational Research, 53*(4), 445-459.

Clark, R.E. & Craig, T.G. (1992). Research and theory of multimedia learning effects. In M. Giardina (Ed.)., *Interactive multimedia learning environments: human factors and technological considerations on design issues* (pp. 19-30). New York: Springer-Verlag.

Cockerton, T. & Shimell, R. (1997). Evaluation of a hypermedia document as a learning tool. *Journal of Computer Assisted Learning, 13*, 133-144.

Coffey, A. & Atkinson, P. (1996). *Making sense of qualitative data: complementary research strategies*. California: Sage.

Collins, A., Brown J.S. & Holum, A (1991) 'Cognitive apprenticeship: making thinking visible', *American Educator*, Winter, 6-11 and 38-46

Collis, B. & Meeuwsen, E. (1999). Learning to learn in a www-based environment. In C. Johnson, C. Hale, D. French & G. Farr (Eds.), *Internet-based learning: an introduction and framework for higher education and business* (pp. 25-46). Kogan page.

Conole, G. and Dyke, M. (2004) "What are the affordances of information and communication technologies?", *ALT-J*, Vol 12, No 2, 115-124.

Conrad, R. & Donaldson, J.A. (2004). *Engaging the online learner: activities and resources for creative instruction.* San Francisco: Jossey-Bass.

Collins, A., Brown, J.S. & Holum, A. (1991). Cognitive apprenticeship: making thinking visible. *American Educator*, Winter, 6-11 and 38-46.

Cooper, P.A. (1993). Paradigm shifts in designed instruction: from behaviorism to cognitivism to constructivism. *Educational Technology, 33*(5), 12-19.

Crook, C.K. (1994). *Computers and the collaborative experience of learning*. London: Routledge.

Crook, C. (1997a). Designing for informal undergraduate computer-mediated communication. *Active Learning, 7*, 47-51.

Crook, C. K. (1997b) "Making hypertext lecture notes more interactive: undergraduate reactions", *Journal of Computer Assisted Learning, 13*, 236–244.

CTGV (The Cognition and Technology Group at Vanderbilt). (1990). Anchored instruction and it's relationship to situated cognition. *Educational Researcher, 19*(6), 2-10.

CTGV (The Cognition and Technology Group at Vanderbilt). (1992). The Jasper series as an example of anchored instruction: theory, program description, and assessment data. *Educational Psychologist, 27*(3), 291-315.

CTGV (The Cognition and Technology Group at Vanderbilt). (1993a). Integrated media: toward a theoretical framework for utilizing their potential. *Educational Technology, 12*(2), 71-85.

CTGV (The Cognition and Technology Group at Vanderbilt). (1993b). Anchored instruction and situated cognition revisited. *Educational Technology, 33*(3), 52-70.

Czaja, R. & Blair, J. (1996). *Designing surveys: a guide to decisions and procedures.* Thousand Oaks, California: Pine Forge Press.

Denzin, N.K. & Lincoln, Y.S. (1994) (Eds.). *Handbook of qualitative research methods.* Thousand Oaks, California: Sage.

Denzin, N.K. & Lincoln, Y.S. (1994). Introduction: entering the field of qualitative research. In N.K. Denzin & Y.S. Lincoln (Eds.), *Handbook of qualitative research methods* (pp. 1-17). Thousand Oaks, California: Sage.

Dick, W. (1997). A model for the systematic design of instruction. In R.D. Tennyson, F. Schott, N.M. Seel & S. Dijkstra (Eds.), *Instructional design – international perspectives volume I: theory, research, and models* (pp. 361-369). Mahwah, New Jersey: Lawrence Erlbaum.

Dick, W. (1992). An instructional designer's view of constructivism. In T. M. Duffy and D. H. Jonassen (Eds.), *Constructivism and the technology of instruction: a conversation* (pp.91-98). New Jersey: Lawrence Erlbaum Associates.

Dick, W. & Carey, L. (1996). *The systematic design of instruction* (4th ed.). New York: Harper Collins.

Dillon, A. & Gabbard, R. (1998). Hypermedia as an educational technology: a review of the quantitative research literature on learner comprehension, control and style. *Review of Educational Research, 68*(3), 322-349.

Dix, A., Finlay, J., Abowd, G. & Beale, R. (2003). *Human-computer interaction* (3rd ed.). Prentice Hall.

Draper, S.W., Brown, M.I., Henderson, F.P. & McAteer, E. (1996). Integrative evaluation: an emerging role for classroom studies of CAL. *Computers and Education, 26*(1-3), 17-32.

Dubois, M. & Vial, I. (2000). Multimedia design: the effects of relating multimodal information. *Journal of Computer Assisted Learning, 16*(2), 157-165.

Duff, A. (1997). A note on the reliability and validity of a 30-item version of Entwistle and Tait's revised approaches to studying inventory. *British Journal of Educational Psychology, 67*, 529-539.

Duffy, T.M. and Jonassen, D.H. (1992) (Eds) *Constructivism and the technology of instruction: a conversation*, Lawrence Erlbaum, New Jersey.

Duffy, C., Arnold, S. & Henderson, F. (1995). Netsem – electrifying undergraduate seminars. *ALT-J, 2*(4).

Dunlap, J.C. & Grabinger, R.S. (1996). Rich environments for active learning in the higher educational classroom. In B.G. Wilson (Ed.), *Constructivist learning environments: case studies in instructional design* (pp. 65-82). Englewood Cliffs, New Jersey: Educational Technology Publications.

Edelson, D.C., Pea, R.D., & Gomez, L. (1996). Constructivism in the collaboratory. In B.G. Wilson (Ed.), *Constructivist learning environments: case studies in instructional design* (pp. 151-164). Englewood Cliffs, New Jersey: Educational Technology Publications.

Ellis, D., Ford, N. & Wood, F. (1993). Hypertext and learning styles. *The Electronic Library, 11*(1), 13-18.

Ely, M., Anzul, M., Friedman, T., Garner, D. & Steinmetz, A.M. (1991). *Doing qualitative research: circles within circles.* London: The Falmer Press.

Entwistle, N. (1988). Motivational factors in students' approaches to learning. In R.R. Schmeck (Ed.), *Learning strategies and learning styles* (pp. 21-51). New York: Plenum Press.

Entwistle, N. (1997). Contrasting perspectives on learning. In F. Marton, D. Hounsell & N. Entwistle (Eds.), *The experience of learning: implications for teaching and studying in higher education (2nd edition)* (pp. 3-22). Edinburgh: Scottish Academic Press.

Entwistle, N. (1998). Approaches to studying and forms of understanding. In B. Dart & G. Boulton-Lewis (Eds.), *Teaching and learning in higher education* (pp. 72-101). Victoria: The Australian Council for Educational Research.

Entwistle, N. (2001). Styles of learning and approaches to studying in higher education. *Kybernetes, 30*(5/6), 593-602.

Entwistle, N. (2003a). Enhancing teaching-learning environments to encourage deep learning. In E. De Corte (Ed.), *Excellence in higher education* (pp. 83-96). London: Portland Press.

Entwistle, N. (2003b). *Concepts and conceptual frameworks underpinning the ETL project: occasional report 3.* Published by ETL Project, Universities of Edinburgh, Coventry and Durham.

Entwistle, N., Hanley, M. & Hounsell, D. (1979a). Identifying distinctive approaches to studying. *Higher Education, 8*, 365-380.

Entwistle, N.J., Hanley, M. & Ratcliffe, G. (1979b). Approaches to learning and levels of understanding. *British Educational Research Journal, 5*, 99-114.

Entwitstle, N. & Ramsden, P. (1983). *Understanding student learning*. New York: Nicholls Publishing Company.

Entwistle, N.J. & Entwistle, A. (1991). Contrasting forms of understanding for degree examinations: the student experience and its implications. *Higher Education*, *22*, 205-227.

Entwistle, N.J., Entwistle, A.C. and Tait, H. (1992). Academic understanding and contexts to enhance it: a perspective from research on student learning. In T. Duffy and D. Jonassen (Eds.), *The design of constructivist learning environments* (pp.331-357). Berlin: Springer Verlag.

Entwistle, N. & Marton, F. (1994). Knowledge objects: understandings constituted through intensive academic study. *British Journal of Educational Psychology*, *64*, 161-178.

Erlandson, D.A., Harris, E.L., Skipper, B.L. & Allen, S.D. (1993). *Doing naturalistic inquiry: a guide to methods*. London: Sage.

Ertmer, P.A. & Newby, T.J. (1993). Behaviorism, cognitivism, constructivism: comparing critical features from an instructional design perspective. *Performance Improvement Quarterly*, *6*(4), 50-72.

Federico, P. (2000). Learning styles and student attitudes toward various aspects of networked-based instruction. *Computers in Human Behavior, 16*(4), 359-379.

Fitzgerald, G.E. & Semrau, L.P. (1998). The effects of learner characteristics on usage patterns and learning outcomes with hypermedia case studies. *Journal of Educational Multimedia and Hypermedia*, *7*(4), 309-331.

Fitzgerald, G.E., Wilson, B. & Semrau, L.P. (1997). An interactive multimedia program to enhance teacher problem-solving skills based on cognitive flexibility theory: design and outcomes. *Journal of Educational Multimedia and Hypermedia*, *6*(1), 47-76.

Flavell, J.H. (1987). Speculations about the nature and development of metacognition. In F.E. Weinert & R.H. Kluwe (Eds.), Metacognition, motivation and understanding (pp. 21-29). Hillside, New Jersey: Lawrence Erlbaum.

Flavell, J.H. (1985). *Cognitive development* (2nd ed.). Englewood Cliffs, New Jersey: Prentice-Hall.

Flavell, J.H. (1963). *The developmental psychology of Jean Piaget*. Princeton, New Jersey: Van Nostrand.

Ford, N. (2000). Cognitive styles and virtual environments. *Journal of the American Society for Information Science, 51*(6), 543-557.

Gagne, R.M. (1985). *The conditions of learning and theory of instruction* (4th edition). New York: Holt, Rinehart and Winston.

Gagne, R.M., Briggs, L.J. & Wager, W.W. (1992). *Principles of instructional design* (4th edition). Harcourt Brace College Publishers.

Garside, C. (1996). Look who's talking: a comparison of lecture and group discussion teaching strategies in developing critical thinking skills. *Communication Education, 45*, 212-227.

Gaver, W.W. (1996). Situating action II: affordances for interaction: the social is material for design. *Ecological Psychology, 8*(2), 111-129.

Gaver, W.W. (1992). The affordances of media spaces for collaboration. In J. Turner & R. Kraut (Eds.), *CSCW2: sharing perspectives. Proceedings of the conference on computer-supported cooperative work* (pp. 17-24). October 31st to November 4th, Toronto, Canada. ACM Press.

Gibbs, G. (1992). *Improving the quality of student learning.* Oxford: Oxford Centre for Staff Development.

Gibbs, G.R. (1999). Learning to learn in a virtual environment for philosophy. *Journal of Computer Assisted Learning, 15*(3), 221-231.

Gibson, J.J. (1979). *The ecological approach to visual perception.* Boston: Houghton Mifflin.

Gibson, J.J. (1977). The theory of affordances. In R. Shaw & J. Bransford (Eds.), *Perceiving, acting and knowing* (pp. 67-82). Hillside, New Jersey: Lawrence Erlbaum.

Gillani, B.B. (2003). *Learning theories and the design of e-learning environments.* Maryland: University Press of America.

Gilliver, R.S., Randall, B. & Pok, Y.M. (1998). Learning in cyberspace: shaping the future. *Journal of Computer Assisted Learning, 14*(3), 212-222.

Good, T.L. & Brophy, J.E. (1990). *Educational psychology: a realistic approach* (4th ed.). New York: Longman.

Goodyear, P. (1996). Asynchronous peer interaction in distance education: the evolution of goals, practices and technology. *Training research Journal, 1*, 71-102.

Goodyear, P. (1997). The ergonomics of learning environments: learner-managed learning and new technology. Keynote address, Edutec'97: 3rd congress on new information technologies for learning. Malaga, Spain, October 1997. Published in the conference proceedings Creacion de materials para la innovacion educative con nuevas tecnologais, instituto de ciencias de la educacion, universidad de malage (pp. 7-17). Online: http://domino.lancs.ac.uk/edres/csaltdocs.nsf.

Goodyear, P. (1999) *Environments for lifelong learning: ergonomics, architecture, and the practice of learning technology*, CSALT report. Online: http://domino.lancs.ac.uk/edres/csaltdocs.nsf.

Goodyear, P. (2002). Psychological foundations for networked learning. In C. Steeples & C.Jones (Eds). *Networked learning: perspectives and issues* (pp.49-75). London: Springer.

Goodyear, P., Njoo, M., Hijne, H. & van Berkum, J.J.A. (1991). Learner processes, learner attributes and simulations. *Education and Computing*, 6(3/4), 263-304.

Goodyear, P. & Steeples, C. (1992). IT-based open learning: tasks and tools. *Journal of Computer Assisted Learning, 8*(3), 163-176.

Goodyear, P., Asensio, M., Jones, C., Hodgson, V. & Steeples, C. (2003). Relationships between conceptions of learning, approaches to study and students' judgements about the value of their experiences of online learning.. *ALT-J, 11*(1), 17-27.

Goodyear, P., Banks, S., Hodgson, V. and McConnell, D. (Eds) (2004) *Advances in Research on Networked Learning*, Kluwer.

Grabinger, R.S. & Dunlap, J.C. (1995). Rich environments for active learning: a definition", *ALT-J, 3*(2), 5-34.

Grabinger, R.S., Dunlap, J.C. & Duffield, J.A. (1997). Rich environments for active learning in action: problem-based learning. *ALT-J, 5*(2), 5-17.

Greeno, J.G. (1989). A perspective on thinking. *American Psychologist, 44*(2), 134-141.

Greeno, J.G. (1994). Gibson's affordances. *Psychological Review, 101*(2), 336-342.

Guba, E.G. & Lincoln, Y.S. (1994). Competing paradigms in qualitative research. In N.K. Denzin & Y.S. Lincoln (Eds.), *Handbook of qualitative research methods* (pp. 105-117). Thousand Oaks, California: Sage.

Gunawardena, C.N., Lowe, C.A. & Anderson, T. (1997). Analysis of a global online debate and the development of an interaction analysis model for examining social construction of knowledge in computer conferencing. *Journal of Educational Computing Research, 17*(4), 397-431.

Gunn, C. (1997). CAL evaluation: future directions. *ALT-J, 5*(1), 40-47.

Hammond, M. (1994). Measuring the impact of IT on learning. *Journal of Computer Assisted Learning*, 10, 251-260.

Hannafin, M.J. (1992). Emerging technologies, ISD, and learning environments: critical perspectives. *Educational Technology Research and Development,* 40(1), 49-63.

Hannafin, M.J., Hannafin, K.M., Land, S.M. & Oliver, K. (1997). Grounded practice and the design of constructivist learning environments. *Educational Technology Research and Development*, 45(3), 101-117.

Hannafin, M.J. & Land, S.M. (1997). The foundations and assumptions of technology enhanced student centered learning environments. *Instructional Science,* 25, 167-202.

Hannafin, M.J. & Land, S.M. (2000). Technology and student-centered learning in higher education: Issues and practices. *Journal of Computing in Higher Education, 12*(1), 3-30.

Hara, N., Bonk, C.J. & Angeli, C. (2000). Content analysis of online discussion in an applied educational psychology course. *Instructional Science, 28*(2), 115-152.

Harasim, L. (1990). Online education: an environment for collaboration and intellectual amplification. In L.M. Harasim (Ed.), *Online education: perspectives on a new environment* (pp.39-64). New York: Praeger.

Harasim, L., Hiltz, S. R., Teles, L. & Turoff, M. (1995). *Learning networks: a field guide to teaching and learning online*. Cambridge, MA: MIT Press.

Harvey, J. (Ed.) (1998). *Evaluation cookbook.* Edinburgh: LTDI (Learning Technology Dissemination Initiative). Edinburgh: Heriot-Watt University.

Hattie, J. & Purdie, N. (1998). The Solo Model: Addressing fundamental measurement issues. In B. Dart, G. Bourton-Lewis (Eds), *Teaching and Learning in Higher Education* (pp 145-176). Victoria: The Australian Council for Educational Research.

Henri, F. (1991). Distance learning and computer-mediated communication: Quasi-interactive or monologue? In C. O'Malley (Ed) *Computer Supported Collaborative Learning,* (pp 145-161). NATO ASI Series, Series F: Computer and Systems Sciences, vol 128.

Hill, J.R. & Hannafin, M.J. (1997). Cognitive strategies and learning from the world wide web. *Educational Technology Research and Development,* 45(4), 37-64.

Hill, J.R. (2000). Web-based instruction: prospects and challenges. In R.M. Branch & M.A. Fitzgerald (Eds.), *Educational media and technology handbook volume 25* (pp. 141-155). Englewood, Colorado: Libraries Unlimited.

Hiltz, S.R. (1994). *The virtual classroom: learning without limits via computer networks*. New Jersey: Ablex Publishing Corporation.

Hiltz, S.R. (1997). Impacts of college level courses via asynchronous learning networks: some preliminary results. *JALIN (Journal of Asynchronous Learning Networks)*, 1(2), 1-19.

Honebein, P. Duffy, T. M. and Fishman, B. (1993) "Constructivism and the design of learning environments: context and authentic activities for learning", In T.M. Duffy, J. Lowyck, and D. Jonassen (Eds), *Designing environments for constructivist learning*, Springer-Verlag, Heidelberg.

Honebein, P.C. (1996). Seven goals for the design of constructivist learning environment. In B.G. Wilson (Ed), *Constructivist Learning Environments: Case Studies in Instructional Design*, (pp11-24). Englewood Cliffs, NJ: Educational Technology Publications.

Honey, P. & Mumford, A. (1992). *The manual of learning styles* (3^{rd} edition). Maidenhead, UK: Peter Honey.

Hounsell, D. (1997). Understanding teaching and teaching for understanding. In F. Marton, D. Hounsell & N. Entwistle (Eds), *The Experience of Learning: Implications* *for Teaching and Studying in Higher Education* (2nd Ed) (pp.238-257). Edinburgh: Scottish Academic Press.

Hyde, R.T., Shaw, P.N. & Jackson, D.E. (1996). The evaluation of integrated courseware: can interactive molecular modelling help students understand three-dimensional chemistry? *Computers and Education, 26*(4), 233-239.

Jacobson, M.J. & Spiro, R.J. (1995). Hypertext learning environments, cognitive flexibility and the transfer of complex knowledge: an empirical investigation. *Journal of Educational Computing Research*, 12(5), 301-333.

Jacobson, M.J., Maouri, C., Mishra, P. & Kolar, C. (1996). Learning with hypertext learning environments: theory, design, and research. *Journal of Educational Multimedia and Hypermedia, 5*(3/4), 239-281.

Janesick, V.J. (1994). The dance of qualitative research design: metaphor, methodolatry, and meaning. In N.K. Denzin & Y.S. Lincoln (Eds.), *Handbook of qualitative research methods* (pp. 209-219). Thousand Oaks, California: Sage.

Jarz, E.M., Kainz, G.A. & Walpoth, G. (1997). Multimedia-based case studies in education: design, development, and evaluation of multimedia-based case studies. *Journal of Educational Multimedia and Hypermedia, 6*(1), 23-46.

Jochems W, van Merrienboer J and Koper R (2004) (eds) *Integrated e-learning: implications for pedagogy, technology and organization* (pp126-138), London, Routledge

Jonassen, D.H. (1989). Designing structured hypertext and structuring access to hypertext. *Educational Technology, 28*(11), 13-19.

Jonassen, D.H. (1990). Semantic network elicitation: tools for structuring hypertext. In R. McAleese & C. Green (Eds.), *Hypertext: state of the art* (pp.142-152). London: Intellect.

Jonassen, D.H. (1991). Objectivism versus constructivism: do we need a new philosophical paradigm? *Educational Technology Research and Development, 39*(3), 5-14.

Jonassen, D.H. (1992a). Evaluating constructivist learning. In T.M. Duffy & D.H. Jonassen (Eds.), *Constructivism and the technology of instruction* (pp. 137-148). New Jersey: Lawrence Erlbaum.

Jonassen, D.H. (1992b). Cognitive flexibility theory and it's implications for designing CBI. In S. Dijkstra, H.P.M. Krammer, & J.J.G. Van Merrienboer (Eds.), *Instructional models in computer-based learning environments* (pp. 385-403). Berlin: Springer-Verlag.

Jonassen, D.H. (1993). Thinking technology: the trouble with learning environments. *Educational Technology*, 33(1), 35-37.

Jonassen, D.K. & Mandel, H. (Eds.) (1990). *Designing hypermedia for learning.* London: Springer-Verlag

Jonassen, D.H. & Grabinger, S.R. (1990). Problems and issues in designing hypertext/hypermedia for learning. In D.K. Jonassen & H.Mandl (Eds.), *Designing hypermedia for learning* (pp.3-26). London: Springer-Verlag

Jonassen, D.H. & Grabowski, B.L. (1993). *Handbook of Individual Differences, Learning and Instruction.* Hillsdale, New Jersey: Lawrence Erlbaum.

Jonassen, D.H. & Wang, S. (1993). Acquiring structural knowledge from semantically structured hypertext. *Journal of Computer-Based Instruction, 20*(1), 1-8.

Jonassen, D.H., Campbell, J.P. & Davidson, M.E. (1994). Learning with media: restructuring the debate. *Educational Technology Research and Development*, 42(2), 31-39.

Jonassen, D.H., Myers, J.M. & McKillop, A.M. (1996). From constuctivism to constructionism: learning with hypermedia/multimedia rather than from IT. In B.G. Wilson (Ed), *Constructivist Learning Environments: Case Studies in Instructional Design* (pp.93-106). Englewood Cliffs, NJ: Educational Technology Publications.

Jonassen, D.H., Dyer, D., Peters, K., Robinson, T., Harvey, D., King, M. & Loughner, P. (1997). Cognitive flexibility hypertexts on the web: engaging learners in meaning making. In B.H. Khan (Ed.), *Web-based instruction* (pp. 119-133). Englewood Cliffs, New Jersey: Educational Technology Publications.

Jonassen, D.H. (1999). "Designing constructivist learning environments". In C.M Reigeluth (Ed). *Instructional design theories and models: a new paradigm of instructional theory* (pp.215-239). Lawrence Erlbaum.

Jones, C. (1999). From the sage on the stage to what exactly? Description and the place of the moderator in co-operative and collaborative learning. *ALT-J,* 7(2), 27-36.

Jones, C., Asensio, M. & Goodyear, P. (2000). Networked learning in higher education: practitioners' perspectives. *ALT-J*, 8(2), 18-28.

Jones, C. & Asensio, M. (2001). Experiences of assessment: using phenomenography for evaluation. *Journal of Computer Assisted Learning, 17*(3), 314-321.

Jones, C. & Steeples, C. (2002). Perspectives and issues in networked learning. In C. Jones & C. Steeples (Eds). Networked learning: perspectives and issues (pp.1-14). Springer.

Karuppan, C.M. (2001). Web-based teaching materials: a user's profile. *Internet Research - Electronic Networking Applications, 11*(2), 138-148.

Kashihara, A., Hiroshi, U. & Toyoda, J. (1999). Reflection support for learning in hyperspace. *Educational Technology*, 39(5), 19-22.

Kaye, A.R. (Ed.) (1992). *Collaborative learning through computer conferencing: the Najaden papers.* Berlin: Springer-Verlag.

Kerka, S. (1995). *Techniques for authentic assessment: practice application brief.* ERIC (Educational Resources Information Center): Clearinghouse on adult, career, and vocational education. Online: http://ericacve.org/.

Kolb, D. A. (1984). *Experiential learning: experience as the source of learning and development.* New Jersey: Prentice-Hall.

Kolb, D.A. (1985). *Learning style inventory and technical manual.* Boston: McAteer.

Kolodner, J, & Guzdial, M. (2000). Theory and practice of case-based learning aids. In D.H. Jonassen and S.M. Land (Eds). *Theoretical Foundations of Learning Environments* (pp.215-242). Lawrence Erlbaum.

Koory, M.A. (2003). Differences in learning outcomes for the online and F2F versions of "an introduction to Shakespeare". *JALN, 7*(2), 18-35.

Land, S.M. & Hannafin, M.J. (1996). Student centered learning environments: foundations, assumption and implications. In 18th Annual Proceedings of Selected Research and Development Presentations, at the 1996 convention of the Association for Educational Communications and Technology, Sponsored by the Research and Theory Division in Indianapolis. Edited by Michael R. Simonson. Iowa State University, College of Education, Instructional Resource Center, (pp.395-400).

Land, S.M. and Hannafin, M.J. (2000) "Student-centered learning environments". In D.H. Jonassen and S.M. Land (Eds). *Theoretical Foundations of Learning Environments* (pp.1-24). Lawrence Erlbaum.

Large, A., Beheshti, J., Breuleux, A. & Renaud, A. (1994). Multimedia and comprehension: a cognitive study. *Journal of the American Society for Information Science*, 45(7), 515-528.

Large, A., Beheshti, J., Breuleux, A. & Renaud, A. (1995). Multimedia, and comprehension: the relationship among text, animation and captions. *Journal of the American Society for Information Science, 46*(5), 340-347.

Larkin, J. H., & Simon, H. A. (1987). Why a diagram is (sometimes) worth ten thousand words. *Cognitive Science, 11*(1), 65-100.

Laurillard, D. (2002). *Rethinking university teaching* (2nd edition). London: RoutledgeFalmer.

Laurillard, D., Stratfold,M., Luckin, R., Plowman, L. & Taylor, J. (2000). Affordances for learning in a non-linear narrative medium. *Journal of Interactive Media in Education*, 2. Available online: http://www-jime.open.ac.uk/00/2

Lave, J. (1988). *Cognition in practice: mind, mathematics, and culture in everyday life.* New York: Cambridge University Press

Lave, J. & Wenger, E. (1991). *Situated learning: legitimate, peripheral participation.* New York: Cambridge University Press.

Lebow, D. (1993). Constructivist values for instructional systems design: five principles toward a new mindset. *Educational Technology Research and Development*, 41(3), 4-16.

Lee, M. (2001). Profiling students' adaptation styles in web-based learning. *Computers and Education, 36*(2), 121-132.

Lee, Y.B. & Lehman, J.D. (1993). Instructional cuing in hypermedia: a study with active and passive learners. *Journal of Educational Multimedia and Hypermedia*, 2(1), 25-37.

Light, P., Colbourn, C. & Light, V. (1997). Computer mediated tutorial support for conventional university courses. *Journal of Computer Assisted Learning*, 13, 228-235.

Light, V., Nesbitt, E., Light, P. & Burns, J.R. (2000). 'Lets you and me have a little discussion': Computer mediated communication in support of campus-based university courses. *Studies in Higher Education*, 25(1), 85-96.

Lin, X., Bransford, J.D., Hmelo, C.E., Kantor, R.J., Hickey, D.T., Secules, T., Petrosino, A.J. & Goldman, S.R. (The Cognition and Technology Group at Vanderbilt), (1996). Instructional design and development of learning communities: an invitation to a dialogue. In B.G. Wilson (Ed), *Constructivist Learning Environments: Case Studies in Instructional Design,* (pp.203-220). Englewood Cliffs, NJ: Educational Technology Publications.

Lindsay, P.H. & Norman, D.H. (1972). *Human Information Processing: An Introduction to Psychology.* New York: Academic Press.

Linn, R.L., Baker, E.L. & Dunbar, S.B. (1991). Complex, performance-based assessment: expectations and validation criteria. *Educational Researcher, 20*(8), 15-21.

Littlejohn, A. & Sclater, N. (1999). The virtual university as a conceptual model for faculty change and innovation. *Journal of Interactive Learning Environments, 7*(2/3), 209-227.

Liu, M. & Reed, W.M. (1994). The relationship between the learning strategies and learning styles in a hypermedia environment. *Computers in Human Behavior, 10*(4), 419-434.

Lo, J. & Shu, P. (2005). Identification of learning styles online by observing learners' browsing behaviour through a neural network. *British Journal of Educational Technology, 36*(1), 43-55.

Loomis, K.D. (2000). Learning styles and asynchronous learning: compairing the LASSI model to class performance. *Journal of Asynchronous Learning Networks,* 4(1), June, 23-31. Online: http://www.aln.org/alnweb/journal/jaln-vol4issue1.htm.

MacKinnon, L. M., McAndrew, P. and Flockhart, S. (1998) *ASTEP Framework User Manual.* Online: http://www.cee.hw.ac.uk/~astep/deliverables/d24v12.pdf

Maki, R.H., Maki, W.S., Patterson, M. & Whittaker, P.D. (2000). Evaluation of a web-based introductory psychology course: I.learning and satisfaction in on-line versus lecture courses. *Behaviour research Methods, Instruments and Computers, 32*(2), 230-239.

Marton, F. (1994). Phenomenography. In T. Husen and N. Postlethwaite (Eds). *International encyclopaedia of education* (pp.4424-4429). Pergamon.

Marton, F. (1998). Phenomenography – exploring different conceptions of reality. In D. Fetterman (Ed), *Qualitative approaches to evaluation in education: the silent revolution* (pp. 176-205). New York: Praeger.

Marton, F., Dall'alba, G. & Beatty, E. (1993). Conceptions of learning. *International Journal of Educational Research, 19*, 277-300.

Marton, F., Hounsell, D. & Entwistle, N. (Eds) (1997). *The experience of learning: implications for teaching and studying in higher education* (2nd ed.). Edinburgh: Scottish Academic Press.

Marton, F. & Saljo, R. (1976a). On qualitative differences in learning I: outcome and process. *British Journal of Educational Psychology*, 46, 4-11.

Marton, F. & Saljo, R. (1976b). On qualitative differences in learning II: outcome as a function of the learner's conception of task. *British Journal of Educational Psychology*, 46, 115-127.

Marton, F. & Saljo, R. (1997). Approaches to learning. In F. Marton, D. Hounsell & N. Entwistle (Eds), *The experience of learning: implications for teaching and studying in higher education* (2nd ed.) (pp. 39-58). Edinburgh: Scottish Academic Press.

Marttunen, M. (1997). Electronic mail as a pedagogical delivery system: an analysis of the learning of argumentation. *Research in Higher Education,* 38(3), 345-363.

Mason, J. (1996). *Qualitative researching*. London: Sage.

Mason, R. (1994) *Using Communications Media in Open and Flexible Learning*, Kogan Page.

Mason, R. & A. Kaye (Eds.) (1989). *Mindweave: communication, computers and distance education*. Oxford: Pergamon Press.

Maxwell, J.A. (1998). Designing a qualitative study. In L. Bickman & D.J. Rog (Eds), *Handbook of applied social research methods* (pp. 69-100). Thousand Oaks, California: Sage.

Mayer, R.E. (1983). *Thinking, Problem Solving, Cognition.* New York: W.H. Freeman and Company.

Mayer, R.E. (1987). *Educational Psychology: A Cognitive Approach*. Harper Collins.

Mayer, R.E. (1989). Systematic thinking fostered by illustrations in scientific text. *Journal of Educational Psychology, 81*(2), 240-246.

Mayer, R.E. & Anderson, R.B. (1991). Animations need narrations: an experimental test of a dual-coding hypothesis. *Journal of Educational Psychology, 83*(4), 484-490.

Mayer, R.E. & Anderson, R.B. (1992). The instructive animation: helping students build connections between words and pictures in multimedia learning. *Journal of Educational Psyhcology*, 84(4), 444-452.

Mayer, R.E. & Gallini, J.K. (1990). When is an illustration worth a thousand words? *Journal of Educational Psychology, 82*(4), 715-726.

Mayer, R.E. & Moreno, R. (1998). A split-attention effect in multimedia learning: evidence for dual-processing systems in working memory. *Journal of Educational Psychology, 90*(2), 312-320.

Mayer, R.E., Moreno, R., Boire, M. & Vagge, S. (1999). Maximising constructivist learning from multimedia communications by minimising cognitive load. *Journal of Educational Psychology, 91*(4), 638-643.

Mayer, R.E. (2001). *Multimedia learning*. Cambridge.

Mayer, R.E. & Moreno, R. (2002). Animation as an aid to multimedia learning. *Educational Psychology Review, 14*(1), 87-99.

Mayes, T., Dineen, F., McKendree, J. & Lee, J. (2002). Learning from watching others learn. In C. Steeples & C. Jones (Eds). *Networked learning: perspectives and issues* (pp.213-228). London: Springer.

McAleese, R. & Green, C. (Eds.) (1990). *Hypertext: state of the art.* Oxford: Intellect.

McAteer, E. & Shaw, R. (1994). *Courseware in Higher Education: Evaluation 1: Planning, Developing and Testing.* Produced by the Emashe Group, University of Glasgow. UCoSDA.

McAteer, E., Tolmie, A., Dufy, C. & Corbett, J. (1997). Computer-mediated communication as a learning resource. *Journal of Computer Assisted Learning*, 13, 219-227.

McConnell, D. (2000). *Implementing computer supported cooperative learning (2nd ed.).* London: Kogan page.

McKendree, J., Stenning, K., Mayers, T., Lee, J. & Cox, R. (1998). Why observing a dialogue may benefit learning. *Journal of computer Assisted Learning.* 14(2), 110-119.

McKnight, C., Dillon, A., Richardson, J., Haraldsson, H. & Spinks, R. (1992). Information access in different media. In E.J. Lovesey (Ed.), *Contemporary ergonomics* (pp. 515-519). London: Taylor and Francis.

Mehlenbacher, B., Miller, C.R., Covington, D. & Larsen, J.S. (2000). Active and interactive learning online: a comparison of web-based and conventional writing classes. *IEEE Transactions on Professional Communication, 43*(2), 166-184.

Merill, M.D. (1992). Constructivism and instructional design. In T. M. Duffy and D. H. Jonassen (Eds.), *Constructivism and the technology of instruction: a conversation* (pp.99-114). New Jersey: Lawrence Erlbaum Associates.

Merrill, M.D. (1994). The prescriptive component display theory. In M.D Merrill, *Instructional Design Theory*, Chapter 8, (pp159-176). Englewood Cliffs, New Jersey: Educational Technology Publications.

Merrill, M.D. (2002). First principles of instruction. *ETR&D, 50*(3), 43-59.

Merrill, M.D., Li, Z. & Jones, M.K. (1992). An introduction to instructional transaction theory. In S. Dijkstra, H.P.M. Krammer & J.J.G. Van Merrienboer (Eds.), *Instructional models in computer-based learning environments. NATO ASI series F: computer and systems sciences volume 104* (pp. 15-41). Berlin: Springer-Verlag.

Michas, I.C. & Berry, D.C. (2000). Learning a procedural task: effectiveness of multimedia presentations. *Applied Cognitive Psychology, 14*(6), 555-575.

Miller, G.A. (1956). The magical number seven, plus or minus two: some limits on our capacity for processing information. *Psychological Review, 63*, 81-97.

Miller, S.M. & Miller, K.L (2000). Theoretical and practical considerations in the design of web-based instruction. In B. Abbey (Ed.), *Instructional and cognitive impacts of web-based education* (pp. 156-177). London: Idea Group Publishing.

Mioduser, D., Nachmias, R., Oren, A. & Lahan, O. (1999). Web-based learning environments(WBLE): current implementation and evolving trends. *Journal of Network and Computer Applications.* 22(4), 233-247.

Molenda, M. (1997). Historical and philosophical foundations of instructional design: a North American view. In R.D. Tennyson, F. Schott, N.M. Steel & S. Dijkstra (Eds). *Instructional Design- International Perspectives Volume 1: Theory, Research and Models.* (pp. 41-53). Lawrence Erlbaum.

Morgan, D.L. (1997). *Focus groups as qualitative research (2nd ed.).* Thousand Oaks, California: Sage.

Morse, J.M. (1994). Designing funded qualitative research. In N.K. Denzin & Y.S. Lincoln (Eds.), *Handbook of qualitative research methods* (pp. 220-235). Thousand Oaks, California: Sage.

Musselbrook, K., McAteer, E., Crook, C., Macleod, H. & Tolmie, A. (2000). Learning networks and communication skills. *ALT-J, 8*(1), 71-79.

Meyer, J.H.F. (1988). Student perceptions of learning context and approaches to studying. *South African Journal of Higher Education, 2*(1), 73-82.

Naidu, S., Barrett, J. & Olsen, P. (1995). Improving instructional effectiveness with computer-mediated communication. *ALT-J, 3*(2), 63-75.

Najjar, L.J. (1995). *Dual Coding as a Possible Explanation for the Effects of Multimedia on Learning.* Technical Report GIT-GVU-95-29. Atlanta: Georgia Institute of Technology, Graphics, Visualisation and Usability Center. Sourced at GVU site: http://www.cc.gatech.edu/gvu/reports/.

Najjar, L.J. (1996). Multimedia information and learning. *Journal of Educational Multimedia and Hypermedia, 5*(2), 129-150.

Najjar, L.J. (1997). *A Framework for Learning from Media: The Effects of Materials, Tasks and Tests on Performance.* Technical Report GIT-GVU-97-21. Atlanta: Georgia Institute of Technology, Graphics, Visualisation and Usability Center. Sourced at GVU site: http://www.cc.gatech.edu/gvu/reports/.

Najjar, L.J. (1998). Principles of educational multimedia user interface design. *Human Factors, 40*(2), 311-323.

Nelson, T.H. (1974). *Computer LIB/dream machines: new freedoms through computer screens - a minority report.* Chicago: Hugo's Book Service.

Nelson, T.H. (1981). *Literary machines.* Mindfull Press.

Neuman, D. (1990). Naturalistic inquiry and computer-based instruction: rationale, procedures, and potential. *Educational Technology Research and Development, 37*(3), 39-51.

Newman, D. (1990). Cognitive and technical issues in the design of educational computer networking. In L.M. Harasim (Ed.), *Online education: perspectives on a new environment* (pp. 99-116). New York: Praeger.

Newman, D.R., Johnson, C., Cochrane, C. & Webb. B. (1996). An experiment in group learning technology: evaluating critical thinking in face-to-face and computer-supported seminars. *Interpersonal Computing and Technology, 4*(1), 57-74.

Newman, D.R., Johnson, C., Cochrane, C. & Webb, B. (1997). Evaluating the quality of learning in computer-supported co-operative learning. *Journal of the American Society for Information Science, 48*(6), 484-495.

Newstead, S.E. (1992). A study of two "quick and easy" methods of assessing individual differences in student learning. *British Journal of Educational Psychology. 62*, 299-312.

Norman, D.A. (1982). *Learning and Memory.* San Francisco: W.H. Freeman and Company.

Ocker, R.J. & Yaverbaum, G.J. (1999). Asynchronous computer-mediated communication versus face-to-face collaboration: results on student learning, quality, and satisfaction. *Group Decision and Negotiation, 8*(5), 427-440.

O'Hara, K. and Sellen, A. (1997) "A Comparison of Reading Paper and On-Line Documents", *Proceedings of CHI-97, Special Interest Group on Computer-Human Interaction.*

Oliver, M. (1997). *A Framework for Evaluating the Use of Educational Technology.* BP ELT Report No 1. University of North London. Learning and Teaching Innovation and Development. Online: http://www.unl.ac.uk/latid/elt/report1.htm

Oliver, R., Omari, A. & Herrington, J. (1998). Exploring student interactions in collaborative world wide web computer based learning environments. *Journal of Higher Educational Multimedia and Hypermedia, 7*(2/3), 263-287).

Oppenheim, A.N. (1992*). Questionnaire design, interviewing and attitude measurement.* London: Continuum.

Oppenhiem, A.N. (1994). *Questionnaire Design, Interviewing and Attitude Measurement.* (New Edition). London: Pinter.

Paivio, A. (1971). *Imagery and verbal processes.* New York: Holt, Rinehart and Wilson.

Paivio, A. (1986). *Mental representations: a dual coding approach.* New York: Oxford Press.

Palloff, R.M. and Pratt, K. (2003), *The virtual student: a profile and guide to working with online learners*, Jossey-Bass, San Franciso.

Pang, M.F. & Marton, F. (2003). Beyond "lesson study": comparing two ways of facilitating the grasp of some economic concepts. *Instructional Science, 31*(3), 175-194.

Park, I. & Hannafin, M.J. (1993). Empirically-based guidelines for the design of interactive multimedia. *Educational Technology Research and Development, 41*(3), 63-85.

Pask, G. (1976). Styles and strategies of learning. *British Journal of Educational Psychology*, 46, 128-148.

Pask, G. & Scott, B.C.E. (1972). Learning strategies and individual competence. *Interpersonal Journal of Man-Machine Studies, 24*, 205-229.

Pea, R.D. (1992). Distributed multimedia learning environments: why and how? *Interactive Learning Environments, 2*(2), 73-109.

Pea, R.D. (1993). Practices of distributed intelligence and designs for education. In G. Salomon (Ed.), *Distributed cognitions: psychological and educational considerations* (pp. 47-87). Cambridge: Cambridge University Press.

Perkins, D.N. (1993). Person-plus: a distributed view of thinking and learning. In G. Salomon (Ed.), *Distributed cognitions: psychological and educational considerations* (pp. 88-110). Cambridge: Cambridge University Press.

Phillips, D.C. (1995). The good, the bad, and the ugly: the many faces of constructivism. *Educational Researcher, 24*(7), 5-12.

Piaget, J. (1978). *The Development of Thought: Equilibration of Cognitive Structures.* Oxford: Blackwell.

Pintrch, P.R., Smith, D.A.F., Garcia, T. & McKeachie, W.J. (1993). Reliability and predictive validity of the motivated strategies for learning questionnaire. *Educational and Psychological Measurement,53*, 801-813.

Ramsden, P. (1988). Context and strategy: situational influences on learning. In R.R. Schmeck (Ed.), *Learning strategies and learning styles* (pp. 159-184). New York: Plenum Press.

Ramsden, P. (1992). *Learning to teach in higher education*. London: Routledge.

Ramsden, P. (2003). *Learning to teach in higher education* (2nd edition). London: RoutledgeFalmer

Ramsden, P. & Entwistle, N.J. (1981). Effects of academic departments on students' approaches to studying. *British Journal of Educational Psychology, 51*, 368-383.

Rasmussen, K.L. & Davidson-Shivers, (1998). Hypermedia and learning styles: can performance be influenced? *Journal of Educational Multimedia and Hypermedia, 7*(4), 291-308.

Reed, E.S. (1991). Cognition as the cooperative appropriation of affordances. *Ecological Psychology, 3*(2), 135-158.

Reed, W.M., Ayersman, D.J., & Liv, M. (1996). The effects of students' computer-based prior experiences and instructional exposures on the application of hypermedia-related mental models. *Journal of Educational Computing Research, 14*(2), 185-207.

Reeves, T.C. & Okey, J.R. (1996). Alternative Assessment for constructivist learning environments. In B.G. Wilson (Ed.), *Constructivist learning environments: case studies in instructional design* (pp. 191-202). Englewood Cliffs, New Jersey: Educational Technology Publications.

Reigeluth, C.M. (1983). Instructional design: what is it and why is it? In C.M. Reigeluth (Ed.), *Instructional design theories and models: an overview of their current status* (pp. 3-36). Hillside, New Jersey: Lawrence Erlbaum.

Reigeluth, C.M. (1992). Reflections on the implications of constructivism for educational technology. In T. M. Duffy and D. H. Jonassen (Eds.), *Constructivism and the technology of instruction: a conversation* (pp.149-158). New Jersey: Lawrence Erlbaum Associates.

Reigeluth, C.M (1999). What is instructional design and how is it changing?. In C. Reigeluth (Ed.), *Instructional-design theories and models: a new paradigm of instructional theory volume II* (pp. 5-29). New Jersey: Lawrence Erlbaum.

Reigeluth, C. M. & Merrill, M. D. (1978). A knowledge base for improving our methods of instruction. *Educational Psychologist, 13*, 57-70.

Reigeluth, C.M & Moore, J.M. (1999). Cognitive education and the cognitive domain. In C. Reigeluth (Ed.), *Instructional-design theories and models: a new paradigm of instructional theory volume II* (pp. 51-68). New Jersey: Lawrence Erlbaum.

Relan, A. and Smith, W.C. (1996) "Learning from hypermedia: a study of situated versus endemic learning strategies", *Journal of Educational Multimedia and Hypermedia*, *5*(1), 3-21.

Richardson, J.T.E. (1999). The concepts and methods of phenomenographic research. *Review of Educational Research, 69*(1), 53-82.

Richardson, J.T.E. (1990). Reliability and replicability of the approaches to studying questionnaire. *Studies in Higher Education, 15*(2), 155-168.

Richardson, J.T.E. (2004). Approaches to studying and perceptions of academic quality in a short web-based course. British Journal of Educational Technology, *34*(4), 433-442.

Ricketts, J., Wolfe, F.H., Norvelle, E. & Carpenter, E.H. (2000). Multimedia: asynchronous distributed education - a review and case study. *Social Science Computer Review, 18*(2), 132-146.

Riding, R. & Sadler-Smith, E. (1992). Type of instructional material, cognitive style and learning performance. *Educational Studies, 18*(3), 323-340.

Riding, R., & Rayner, S. (1998). *Cognitive styles and learning strategies*. London: David Fulton Publishers.

Rogers, Y. (1999). What is it about interactive graphical representations? *Learning and Instruction, 9*(4), 419-425.

Romiszowski, A.J. (1997a). Web-based learning and teaching: revolutionary invention or reaction to necessity? In B.H. Khan (Ed.), *Web-based instruction* (pp. 25-37). Englewood Cliffs, New Jersey: Educational Technology Publications.

Romiszowski, A (1997b). The use of telecommunication in education. In S. Dijkstra, N.M. Seel, F. Schot & R.D. Tennyson (Eds) *Instructional design - international perspectives volume II: solving instructional design problems* (pp183-220).Lawrence Erlbaum

Rumelhart, D.E. & Norman, D.A. (1978). Accretion,tuning and restructuring: three modes of learning. In J.W. Cotton & R. Klatzky (Eds.). *Semantic factors in cognition* (pp. 37-53). Hillside, New Jersey: Lawrence Erlbaum.

Ryder, M. & Wilson, B. (1996). Affordances and constraints of the internet for learning and instruction. In M.R. Simonson (Ed.), *18th annual proceedings of selected research and development presentations: 1996 convention of the association for educational communications and technology* (pp. 642-654). Iowa State University, College of Education, Instructional Resource Center.

Sabry, K. & Baldwin, L. (2003). Web-based learning interaction and learning styles. *British Journal of Educational Technology, 34*(4), 443-454.

Sadler-Smith, E. & Riding, R. (1999). Cognitive style and instructional preferences. *Instructional Sciences, 27*(5), 355-371.

Sadler-Smith, E. & Smith, P.J. (2004). Strategies for accommodating individuals' styles and preferences in flexible learning environments. British Journal of Educational Technology, *35*(4), 395-412.

Saettler, P. (1990). *The evolution of american educational technology*. Englewood, Colorado: Libraries Unlimited.

Saljo, R. (1979). *Learning in the learner's perspective I: some common sense perceptions*. Reports from the Institute of Education, University of Goteburg, No. 76.

Saljo, R. (2004). Learning and technologies, people and tools in co-ordinated activities. *International Journal of Educational Research, 41*, 489-494.

Salmon, G. (2002) *E-tivities: the key to active online learning*. Kogan Page.

Salmon, G. (2004) *E-moderating: the key to teaching and learning online* (2nd edition). Kogan Page.

Salomon, G. (1986). Information technologies: what you see is not (always) what you get. *Educational Psychologist, 20*(4), 207-216.

Salomon, G. (1992). The changing role of the teacher: from information transmitter to orchestrator of learning. In F.K. Oser, A. Dick & J. Patry (Eds.), *Effective and responsible teaching: the new synthesis* (pp. 35-49). San Francisco: Jossey-Bass.

Salomon, G. (Ed.) (1993). *Distributed cognitions: psychological and educational considerations.* Cambridge: Cambridge University Press.

Salomon, G. (1994). *Interaction of media, cognition, and learning.* Hillside, New Jersey: Lawrence Erlbaum.

Salomon, G. & Almog, T. (1998). Educational psychology and technology: a matter of reciprocal relations. *Teachers College Record, 100*(1), 222-241.

Savery, J.R. & Duffy, T.M. (1996). Problem based learning: an instructional model and its constructivist framework. In B.G. Wilson (Ed.), *Constructivist learning environments: case studies in instructional design* (pp. 135-148). Englewood Cliffs, New Jersey: Educational Technology Publications.

Saye, J.W. & Brush, T. (1999). Student engagement with social issues in a multimedia-supported learning environment. *Theory and Research in Social Education, 27*(4), 472-504.

Scaife, M. and Rogers, Y. (1996) "External cognition: how do graphical representations work?", *International Journal of Human-Computer Studies*, Vol 45, pp185-213.

Schank, R.C., Berman, T.R. & Macpherson, K.A. (1999). Learning by doing. In C. Reigeluth (Ed.), *Instructional-design theories and models: a new paradigm of instructional theory volume II* (pp. 161-180). New Jersey: Lawrence Erlbaum.

Schiffman, S. S. (1995). Instructional systems design: five views of the field. In G.J. Anglin (Ed.), *Instructional technology: Past, present and future* (2nd edition) (pp. 131-142). Libraries Unlimited.

Schmeck, R.R. (Ed.) (1988). *Learning strategies and learning styles*. London: Plenum Press.

Schunk, D. (1996). *Learning theories* (2nd edition). New Jersey: Prentice-Hall.

Schnotz, W. & Grzondziel, H. (1996). Knowledge acquisition with static and animated pictures in computer-based learning. Paper presented at the annual meeting of the American Educational Research Association (AERA), New York, April 8-12.

Schott, N.M. Seel & S. Dijkstra (Eds.), *Instructional design - international perspectives volume II: theory, research and models* (pp. 327-351). Lawrence Erlbaum.

Schwandt, T.A. (1994). Constructivist, interpretivist approaches to human inquiry. In N.K. Denzin & Y.S. Lincoln (Eds.), *Handbook of qualitative research methods* (pp. 118-137). Thousand Oaks, California: Sage.

Seale, J.K. & Cann, A.J. (2000). Reflection on-line or off-line: the role of learning technologies in encouraging students to reflect. *Computers and Education, 34*(3/4), 309-320.

Sekaran, U. (1992). Research methods for business – a skill building approach (2nd edition). John Wiley.

Shavelson, R.J. & Baxter, G.P. (1992). Linking assessment with instruction. In F.K. Oser, A. Dick & J. Patry (Eds.), *Effective and responsible teaching: the new synthesis* (pp. 80-90). San Francisco: Jossey-Bass.

Shaw, G.P. & Pieter, W. (2000). The use of asynchronous learning networks in nutrition education: student attitude, experiences and performance. *Journal of Asynchronous Learning Networks, 4*(1), 40-51. Online: http://www.aln.org/alnweb/journal/jaln-vol4issue1.htm.

Shih, C., Ingebritsen, T., Pleasants, J., Flickinger, K. & Brown, G. (1998). Learning strategies and other factors influencing achievement via web courses. In *Distance learning '98. Proceedings of the 14th annual conference on distance teaching and learning* (pp. 359-366). August 5-7, 1998, Madison, Wisconsin. University of Wisconsin.

Skinner, B.F. (1968). *The technology of teaching*. New York: Meredith.

Skinner, B.F. (1953). *Science and human behaviour*. New York: Free Press.

Skinner, B.F. (1954). The science of learning and the art of teaching. *Harvard Educational Review, 24*, 86-97.

Slavin, R.E. (1996). Research on cooperative learning and achievement: what we know, what we need to know. *Contemporary Educational Psychology, 21*, 43-69.

Slavin, R.E. (1987). *Cooperative learning: student teams*. Washington, D.C.: National Education Association.

Sloane, A. (1997). Learning with the web: experience of using the world wide web in a learning environment. *Computers and Education, 28*(4), 207-212.

Smeaton, A.F. & Keogh, G. (1999). An analysis of the use of virtual delivery of undergraduate lectures. *Computers and Education, 32*(1), 83-94.

Smyth, K. & Buckner, K. (2000). Individual approaches to studying and the affordances of interacting with networked learning environments. In M. Asensio, J. Foster, V. Hodgson & D. McConnell (Eds). *Networked Learning 2000: Innovative approaches to lifelong learning and higher education through the internet*. Lancaster University and The University of Sheffield, pp. 315-322.

Smyth, K. and Buckner, K. (2004) "Towards a theoretical framework for understanding the nature of networked learning", *Proceedings of The 3rd European Conference on e-learning,* pp.375-386.

Snow, R.E. (1997). Individual differences. In R.D. Tennyson, F. Schott, N.M. Seel & S. Dijkstra (Eds.), *Instructional design - international perspectives volume I: theory, research and models* (pp. 215-241). Lawrence Erlbaum.

Song, L. Singleton, E.S. Hill, J.R. and Koh, M.H. (2004) "Improving online learning: student perceptions of useful and challenging characteristic", *Internet and Higher Education*, *7*, pp.59-70.

Spiro, R.J. & Jehng, J. (1990). Cognitive flexibility and hypertext: theory and technology for the nonlinear and multidimensional traversal of complex subject matter. In D. Nix & R.J. Spiro (Eds.), *Cognition, education and multimedia: explorations in high technology* (pp.163-205). Hillside, New Jersey: Lawrence Erlbaum.

Spiro, R.J., Vispoel, W.P., Schmitz, J.G., Samarapungavan, A. & Boerger, A.E. (1987). Knowledge acquisition for application: cognitive flexibility and transfer in complex content domains. In B.K. Britton & S.M. Glynn (Eds.), *Executive control processes in reading* (pp.177-199). Hillside, New Jersey: Lawrence Erlbaum Associates.

Spiro, R.J., Feltovich, P.J., Jacobson, M.J. & Coulson, R.L. (1991). Cognitive flexibility, constructivism and hypertext: random access instruction for advanced knowledge acquisition in ill-structured domains. *Educational Psychology, 31*(5), 24-33.

Spiro, R.J, Feltovich, P.J., Jacobson, M.J. & Coulson, R.L. (1992). Knowledge representation, content specification, and the development of skill in situation specific knowledge assembly: some constructivist issues as they relate to cognitive flexibility theory and hypertext. In T.M. Duffy & D.H. Jonassen (Eds.), *Constructivism and the technology of instruction* (pp. 121-128). New Jersey: Lawrence Erlbaum.

Stake, R.E. (1994). Case studies. In N.K. Denzin & Y.S. Lincoln (Eds.), *Handbook of qualitative research methods* (pp.236-247). Thousand Oaks, California: Sage.

Stemler, L.K. (1997). Educational characteristics of multimedia: a literature review. *Journal of Educational Multimedia and Hypermedia, 6*(3/4), 339-359.

Steeples, C., Goodyear, P. & Mellar, H. (1994). Flexible lifelong learning in higher education: the use of computer-mediated communications. Computers and Education, *22*(1/2), 83-90.

Steeples, C. & Jones, C. (Eds) (2002). *Networked learning: perspectives and issues.* London: Springer.

Sullivan, K. & Czigler, P. (2002). Maximising the educational affordances of a technology supported environment for introductory undergraduate phonetics. *British Journal of Educational Technology, 33*(3), 333-343.

Sumner, T. & Taylor, J. (1998). Media integration through media-learning environments. In M. Eisenstadt & T. Vincent (Eds.), *The knowledge web: learning and collaborating on the net* (pp.63-78). London: Kogan Page.

Tait, H. & Entwistle, N. (1996). Identifying students at risk through ineffective study strategies. *Higher Education, 31*, 97-116.

Tait, H., Entwistle, N. & McCune, V. (1998). Assist: a reconceptualization of the approaches to studying inventory. In C. Rust (Ed.), *Improving student learning: improving students as learners. Proceedings of the 5th international improving student learning symposium* (pp. 262-271). University of Strathclyde, 1997. Oxford: The Oxford Centre for Staff and Learning Development.

Tait, H., Entwistle, N. & McCune, V. (1997). Assist: a reconceptualization of the approaches to studying inventory. Paper to be presented at the 5th international improving student learning symposium, University of Strathclyde, September 1997. Personal communication received from original author, July 8th, 1998.

Tait, K. (1998). Replacing lectures with multimedia CBL: student attitudes and reactions. *Instructional Science, 26*(6), 409-438.

Taraban, R., Maki, W.S. & Rynearson, K. (1999). Measuring study time distributions: implications for designing computer-based courses. *Behaviour Research Methods, Instruments and Computers, 31*(2), 263-269.

Tennyson, R.D., Schott, F., Seel, N.M. & Dijkstra, S. (Eds.) (1997). *Instructional design - international perspectives volume I: theory, research and models.* Mahwah, New Jersey: Lawrence Erlbaum.

Tennyson, R.D., & Elmore, R.L. (1997). Learning theory foundations for instructional design. In R.D. Tennyson, F. Schott, N.M Seel & S. Dijkstra (Eds.), *Instructional design - international perspectives volume I: theory, research and models* (pp. 55-78). Mahwah, New Jersey: Lawrence Erlbaum.

Tennyson, R.D., & Schott, F. (1997). Instructional design theory, research and models. In R.D. Tennyson, F. Schott, N.M Seel & S. Dijkstra (Eds.), *Instructional design - international perspectives volume I: theory, research and models* (pp.1-16). Mahwah, New Jersey: Lawrence Erlbaum.

Tergan, S. (1997). Misleading theoretical assumptions in hypertext/hypermedia research. *Journal of Educational Multimedia and Hypermedia*, 6(3/4), 257-283.

Thorndike, E.L. (1932). *The fundamentals of learning*. New York: Teachers College Press.

Tolmie, A. & Boyle, J. (2000). Factors influencing the success of computer mediated communication (CMC) environments in university teaching: a review and case study. *Computers and Education, 34*(2), 119-140.

Tu, C. (2000). On-line learning migration: from social learning theory to social presence theory in a CMC environment. *Journal of Network Computer Applications, 23*(1), 27-37.

Tynjala, P. (1997). Developing students' conceptions of the learning process in different learning environments. *Learning and Instruction, 7*(3), 277-292.

Valley, K. (1997). Learning styles and courseware design. *ALT-J, 5*(2), 42-51.

Van Merrienboer, J.J.G. & Dijkstra, S. (1997) The four-component instructional design model for training complex cognitive skills. In R.D. Tennyson, F. Schott, N.M Seel & S. Dijkstra (Eds.), *Instructional design - international perspectives volume I: theory, research and models* (pp.427-445). Mahwah, New Jersey: Lawrence Erlbaum.

Van Merrienboer, J.J.G, Clark, R.E. & de Croock, M.B.M. (2002). Blueprints for complex learning: the 4C/ID model. *ETR&D, 50*(2), pp.39-64.

Van Rossum, E.J. & Schenk, S.M (1984). The relationship between learning conception, study strategy and learning outcome. *British Journal of Educational Psychology, 54*, 73-83.

Veenman, M.V.J., Elshout, J.J. & Busato, V.V. (1994). Metacognitive mediation in learning with computer-based simulations. *Computers in Human Behaviour, 10*(1), 93-106.

Volet, S. & Wosnitza, M. (2004). Social affordances and students' engagement in cross-national online learning. *Journal of Research in International Education, 3*(1), 5-29.

Von Glaserfeld, E. (1984). An introduction to radical constructivism. In P.. Watzlawick (Ed.), *The Invented Reality* (pp.17-40). London: W.W. Norton.

Vygotsky, L.S. (1978). *Mind in society: the development of higher psychological processes*. Cambridge, MA: Harvard University Press.

Ward, M. & Newlands, D. (1998). Use of the web in undergraduate teaching. *Computers and Education, 31*(2), 171-184.

Watson, J.B. (1924). *Behaviorism*. New York: Norton.

Watson, J.S. (1998). "If you don't have it, you can't find it". A close look at students' perceptions of using technology. *Journal of the American Society for Information Science, 49*(11), 1024-1036.

Webb, B., Newman, D.R. & Cochrane, C. (1994). Towards a methodology for evaluating the quality of student learning in a computer-mediated-conferencing environment. In G. Gibbs (Ed.). *Improving student learning: theory and practice* (pp. 329-339). Oxford: The Oxford Centre for Staff Development.

Weller, H.G., Repman, J., Lan, W. & Rooze, G. (1995). Improving the effectiveness of learning through hypermedia based instruction: the importance of learner characteristics. *Computers in Education, 11*(3-4), 451-465.

Weller, M. (2002). Delivering learning on the net: the why, what and how of online education. London: RoutledgeFalmer.

Wenger, E. (2005). Learning for a small planet: a research agenda. Accessed online: http://www.ewenger.com.

Whalley, P. (1992). An alternative rhetoric for hypertext. In A. Dillon, C. McKnight & J. Richardon (Eds.), *Hypertext: a psychological perspective* (pp. 7-17). Chichester: Prentice Hall.

Whitehead, A.N. (1929). *The aims of education*. New York: MacMillan.

Whittington, C.D. & Campbell, L.M. (1999). Task-orientated learning on the web. *Innovations in Education and Training International, 36*(1), 26-33.

Wible, D., Kuo, C., Tsao, N. & Lin, H. (2003). Bootstrapping in a language learning environment. *Journal of Computer Assisted Learning, 19*, 90-102.

Willcoxson, L. & Prosser, M. (1996). Kolb's learning style inventory (1985): a review and further study of validity and reliability. *British Journal of Educational Psychology, 66*, 247-257.

Wilson, B.G. (1996). Introduction: what is a constructivist learning environment? In B.G. Wilson (Ed.), *Constructivist learning environments: case studies in instructional design* (pp. 3-8). Englewood Cliffs, New Jersey: Educational Technology Publications.

Wilson, B.G. & Meyers, K.M. "Situated cognition in theoretical and practical context", In *Theoretical foundations of learning environments* (pp.57-88), D.H. Jonassen and S.M. Land (Eds). Lawrence Erlbaum.

Wilson, T. & Whitelock, D. (1998). What are the perceived benefits of participating in a computer-mediated communication environment for distance learning computer science students? *Computers and Education, 30*(3/4), 259-269.

Windschitl, M. (1998). The WWW and classroom research: what path should we take? *Educational Researcher, 27*(1), 28-33.

Witkin, H., Oltman, P., Raskin, E. & Karp, S. (1971). *A manual for the embedded figures test.* Palo Alto, California: Consulting Psychologists Press.

Witkin, H.A., Moore, C.A., Goodenough, D.R. & Cox, P.W. (1977). Field-dependent and field-independent cognitive styles and their educational implications. *Review of Educational Research, 47*(1), 1-64.

Wittgenstein, L. (1953). *Philosophical investigations*. New York: MacMillan.

Wood, F., Ford, N., Miller, D., Sobczyk, G. & Duffin, R. (1996). Information skills, searching behaviour and cognitive styles for student-centred learning: a computer-assisted learning approach. *Journal of Information Science, 22*(2), 79-92.

Xun, G.E. & Land, S.M. (2004). A conceptual framework for scaffolding ill-structured problem-solving processes using question prompts and peer interactions. *ETR&D, 52*(2), pp.5-22.

Yakimovicz, A.D. & Murphy, K.L. (1995). Constructivism and collaboration on the internet: case study of a graduate class experience. *Computers and Education, 24*(3), 203-209.

Yin, R.K. (1998). The abridged version of case study research: design and method. In L. Bickman & D. Rog (Eds.), *Handbook of applied social research methods* (pp. 229-259). Thousand Oaks, California: Sage.

Young, M.F., DePalma, A. & Garrett, S. (2002). Situations, interaction, process and affordances: an ecological psychology perspective. *Instructional Science, 30*(1), 47-63.

10.0 APPENDICES

EDUCATIONAL EXPERIENCE QUESTIONNAIRE

(EXAMPLE FROM HUMAN FACTORS CASE STUDY)

NB: SHOWN IN LANDSCAPE TO FIT MARGINS OF THIS TRANSCRIPT

HFIM Case Study - Educational Experience Questionnaire

This questionnaire has been distributed as part of the study investigating web-based learning on the HFIM module, and focuses on your experience of computing technology, education, and your preferred approaches to studying. Understanding such factors will provide a valuable insight into how educational web sites can be designed to benefit a wide range of students. Please read all questions carefully before responding truthfully. Seal the completed questionnaire in the envelope provided and deposit it in the box outside the CIS department office labeled 'HFIM Case Study: Completed Questionnaires'.

Questions in A and B derived from the Approaches and Studying Inventory (C) Centre for Research on Learning and Instruction, University of Edinburgh.

A. Approaches to Studying

Please indicate the extent to which you agree or disagree with the following statements. In deciding your answers think in terms of how you typically approach learning on the BA (Hons) Information Management course. Work through the statements quite quickly, giving your immediate response by ticking the appropriate box. Only choose Unsure (U) if you feel certain you can neither agree or disagree with a particular statement.

SA *= Strongly Agree* ***A*** *= Agree* ***U*** *= Unsure* ***D*** *= Disagree* ***SD*** *= Strongly Disagree*

	SA	A	U	D	SD
1. I manage to find conditions for studying which allow me to get on with my work easily.	❑	❑	❑	❑	❑
2. When working on an assignment, I'm keeping in mind how best to impress the marker.	❑	❑	❑	❑	❑
3. Often I find myself wondering if the work I'm doing here is really worthwhile.	❑	❑	❑	❑	❑
4. I usually set out to understand for myself the meaning of what we have to learn.	❑	❑	❑	❑	❑
5. I organise my study time carefully to make the best use of it.	❑	❑	❑	❑	❑
6. I find I have to concentrate on just memorising a good deal of what I have to learn.	❑	❑	❑	❑	❑
7. I look at the evidence carefully and try to reach my own conclusions about what I am studying.	❑	❑	❑	❑	❑

	SA	A	U	D	SD
8. I try to relate ideas I come across to those in other topics or other courses whenever possible.	❑	❑	❑	❑	❑
9. I tend to read very little beyond what is actually required to pass.	❑	❑	❑	❑	❑
10. I think I am quite systematic and organised when it comes to revising for exams.	❑	❑	❑	❑	❑
11. I look carefully at tutors' comments on course work to see how to get higher marks next time.	❑	❑	❑	❑	❑
12. There's not much of the work here that I find interesting or relevant.	❑	❑	❑	❑	❑
13. When I'm reading an article or book , I try to find out for myself exactly what the author means.	❑	❑	❑	❑	❑
14. I'm pretty good at getting down to work whenever I need to.	❑	❑	❑	❑	❑
15. Much of what I'm studying makes little sense, it's like unrelated bits and pieces.	❑	❑	❑	❑	❑
16. When I'm working on a new topic, I try to see in my own mind how all the ideas fit together.	❑	❑	❑	❑	❑
17. Often I find myself questioning things I hear in lectures or read in books.	❑	❑	❑	❑	❑
18. I concentrate on learning just those bits of information I have to know to pass.	❑	❑	❑	❑	❑
19. I'm good at following up some of the reading suggested by my lecturers or tutors.	❑	❑	❑	❑	❑
20. I keep in mind who is going to mark an assignment and what they're likely to be looking for	❑	❑	❑	❑	❑

***SA** = Strongly Agree **A** = Agree **U** = Unsure **D** = Disagree **SD** = Strongly Disagree*

	SA	A	U	D	SD
21. When I look back, I sometimes wonder why I ever decided to come here.	❑	❑	❑	❑	❑
22. When I'm reading I stop from time to time to reflect on what I am trying to learn from it.	❑	❑	❑	❑	❑
23. I work steadily through the term or semester, rather than leave it to the last minute.	❑	❑	❑	❑	❑
24. I'm not really sure what's important in lectures, so I try to get down all I can.	❑	❑	❑	❑	❑
25. Ideas in course books or articles often set me off on long chains of thought of my own.	❑	❑	❑	❑	❑
26. When I read, I examine the details carefully to see how they fit in with what's being said.	❑	❑	❑	❑	❑
27. I gear my studying closely to just what seems to be required for assignments and exams.	❑	❑	❑	❑	❑
28. I usually plan out my weeks work in advance, either on paper or in my head.	❑	❑	❑	❑	❑
29. I keep an eye open for what lecturers seem to think is important and concentrate on that	❑	❑	❑	❑	❑
30. I'm not really interested in this course, but I have to take it for other reasons.	❑	❑	❑	❑	❑
31. Before tackling a problem or assignment, I first try to work out what lies behind it.	❑	❑	❑	❑	❑
32. I generally make good use of my time during the day.	❑	❑	❑	❑	❑

***SA** = Strongly Agree **A** = Agree **U** = Unsure **D** = Disagree **SD** = Strongly Disagree*

	SA	A	U	D	SD
33. I often have trouble making sense of things I have to remember.	❑	❑	❑	❑	❑
34. I like to play around with ideas of my own even if they don't get me very far.	❑	❑	❑	❑	❑
35. It's important for me to be able to follow the argument, or to see the reason behind things.	❑	❑	❑	❑	❑
36. I like to be told precisely what to do in essays or other assignments	❑	❑	❑	❑	❑

B. Preferences for Different Types of Course and Teaching

Please indicate your preferences for different types of course and teaching by ticking the appropriate box next to each statement below. Only choose Unsure (U) if you feel certain that you cannot provide a definite answer either way.

***DL** = Definitely Like **L** = Like Somewhat **U** = Unsure **D** = Dislike **DD** = Definitely Dislike*

	DL	L	U	D	DD
37. Lecturers who tell us exactly what to put down in our notes.	❑	❑	❑	❑	❑
38. Lecturers who encourage us to think for ourselves and show us how they themselves think.	❑	❑	❑	❑	❑
39. Exams which allow me to show that I've thought about the course material for myself.	❑	❑	❑	❑	❑
40. Exams or tests which need only the material provided in our lecture notes.	❑	❑	❑	❑	❑

	DL	L	U	D	DD
41. Courses in which it's made very clear just what books we have to read.	❑	❑	❑	❑	❑
42. Courses where we're encouraged to read around the subject area a lot for ourselves.	❑	❑	❑	❑	❑
43. Books which challenge you and provide explanations which go beyond the lectures.	❑	❑	❑	❑	❑
44. Books which give you definite facts and information which can be easily learned.	❑	❑	❑	❑	❑

C. Computer Literacy and Educational Experience

45. Please rate your level of computer literacy in each of the following areas:

	Expert	Skilled	Intermediate	Limited	Zero
Wordprocessing	❑	❑	❑	❑	❑
Using Windows 3.1	❑	❑	❑	❑	❑
Using Windows 95/98	❑	❑	❑	❑	❑
Information searching using online/CD-ROM databases	❑	❑	❑	❑	❑
Using educational software (e.g. teach yourself/class-based tools)	❑	❑	❑	❑	❑

46. Please rate your level of internet literacy in each of the following areas:

	Expert	Skilled	Intermediate	Limited	Zero
Using a WWW browser (e.g. Netscape, Explorer)	☐	☐	☐	☐	☐
Using a WWW search engine (e.g. AltaVista, Yahoo)	☐	☐	☐	☐	☐
Using E-mail for sending and receiving messages	☐	☐	☐	☐	☐
Using online discussion facilities (e.g. newsgroups, bulletin boards)	☐	☐	☐	☐	☐

47. Please indicate any ways in which you have used the internet as part of a formal educational course (tick all that apply):

- Accessing course materials located on the WWW ☐
- Searching the WWW for information/further reading material ☐
- Using e-mail to communicate with tutors ☐
- Using e-mail to communicate with fellow students ☐
- Using a newsgroup/bulletin board facility for online discussion ☐
- Other(s) (if any, please state) ______________________________

48. Please describe briefly how you feel (e.g positive, negative, apprehensive) about undertaking web-based learning.

____

____

____

49. Have you ever undertaken a supervised course of independent study (e.g. distance or open learning)? **Yes** ☐ **No** ☐

50. Prior to QMC had you ever studied at further/higher educational level (e.g HNC, HND, degree courses)? **Yes** ☐ **No** ☐

51. Did you begin studying at QMC straight from secondary school/sixth form college? **Yes** ☐ **No** ☐

D. Information About Yourself

52. Please indicate your gender.

Male ☐
Female ☐

53. Please indicate which age category you fall into.

Under 21 ☐
21 - 30 ☐
31 - 40 ☐
41 - 50 ☐
51 - 60 ☐
61 + ☐

54. Please state your name *(print in block capitals).* ______________________

Your name is required so that all the data you provide during this study can be analysed as if it were the result of one large survey. Your identity will not be revealed in the final thesis nor in any related publications. Thank you for you cooperation.

EDUCATIONAL EXPERIENCE QUESTIONNAIRE (SCALES GROUPED)

(EXAMPLE FROM HUMAN FACTORS CASE STUDY)

NB: SHOWN IN LANDSCAPE TO FIT MARGINS OF THIS TRANSCRIPT

HFIM Case Study - Educational Experience Questionnaire

This questionnaire has been distributed as part of the study investigating web-based learning on the HFIM module, and focuses on your experience of computing technology, education, and your preferred approaches to studying. Understanding such factors will provide a valuable insight into how educational web sites can be designed to benefit a wide range of students. Please read all questions carefully before responding truthfully. Seal the completed questionnaire in the envelope provided and deposit it in the box outside the CIS department office labeled 'HFIM Case Study: Completed Questionnaires'.

Questions in A and B derived from the Approaches and Studying Inventory (C) Centre for Research on Learning and Instruction, University of Edinburgh.

A. Approaches to Studying

Please indicate the extent to which you agree or disagree with the following statements. In deciding your answers think in terms of how you typically approach learning on the BA (Hons) Information Management course. Work through the statements quite quickly, giving your immediate response by ticking the appropriate box. Only choose Unsure (U) if you feel certain you can neither agree or disagree with a particular statement.

***SA** = Strongly Agree **A** = Agree **U** = Unsure **D** = Disagree **SD** = Strongly Disagree*

DEEP APPROACH

Seeking Meaning Sub-scale

	SA	A	U	D	SD
00. I usually set out to understand for myself the meaning of what we have to learn.	❑	❑	❑	❑	❑
00. When I'm reading an article or book, I try to find out for myself exactly what the author means.	❑	❑	❑	❑	❑
00. When I'm reading I stop from time to time to reflect on what I am trying to learn from it.	❑	❑	❑	❑	❑
00. Before tackling a problem or assignment, I first try to work out what lies behind it.	❑	❑	❑	❑	❑

Relating Ideas Snb-scale

	SA	A	U	D	SD
00. I try to relate ideas I come across to those in other topics or other courses whenever possible.	❑	❑	❑	❑	❑
00. When I'm working on a new topic, I try to see in my own mind how all the ideas fit together.	❑	❑	❑	❑	❑
00. Ideas in course books or articles often set me off on long chains of thought of my own.	❑	❑	❑	❑	❑
00. I like to play around with ideas of my own even if they don't get me very far.	❑	❑	❑	❑	❑

Use of Evidence Sub-scale

	SA	A	U	D	SD
00. I look at the evidence carefully and try to reach my own conclusions about what I am studying.	❑	❑	❑	❑	❑
00. Often I find myself questioning things I hear in lectures or read in books.	❑	❑	❑	❑	❑
00. When I read, I examine the details carefully to see how they fit in with what's being said.	❑	❑	❑	❑	❑
00. It's important for me to be able to follow the argument, or to see the reason behind things.	❑	❑	❑	❑	❑

STRATEGIC APPROACH

Organised Studying Sub-scale

	SA	A	U	D	SD
00. I manage to find conditions for studying which allow me to get on with my work easily.	❑	❑	❑	❑	❑
00. I think I am quite systematic and organised when it comes to revising for exams.	❑	❑	❑	❑	❑
00. I'm good at following up some of the reading suggested by my lecturers or tutors.	❑	❑	❑	❑	❑
00. I usually plan out my weeks work in advance, either on paper or in my head.	❑	❑	❑	❑	❑

Time Management Sub-scale

	SA	A	U	D	SD
00. I organise my study time carefully to make the best use of it.	❑	❑	❑	❑	❑
00. I'm pretty good at getting down to work whenever I need to.	❑	❑	❑	❑	❑
00. I work steadily through the term or semester, rather than leave it to the last minute.	❑	❑	❑	❑	❑
00. I generally make good use of my time during the day.	❑	❑	❑	❑	❑

Alertness to Assessment Demands Sub-scale

	SA	A	U	D	SD
00. When working on an assignment, I'm keeping in mind how best to impress the marker.	❑	❑	❑	❑	❑
00. I look carefully at tutors' comments on course work to see how to get higher marks next time.	❑	❑	❑	❑	❑
00. I keep in mind who is going to mark an assignment and what they're likely to be looking for.	❑	❑	❑	❑	❑
00. I keep an eye open for what lecturers seem to think is important and concentrate on that	❑	❑	❑	❑	❑

SURFACE APATHETIC APPROACH

Lack of Purpose Sub-scale

	SA	A	U	D	SD
00. Often I find myself wondering if the work I'm doing here is really worthwhile.	❑	❑	❑	❑	❑
00. There's not much of the work here that I find interesting or relevant.	❑	❑	❑	❑	❑
00. When I look back, I sometimes wonder why I ever decided to come here.	❑	❑	❑	❑	❑
00. I'm not really interested in this course, but I have to take it for other reasons.	❑	❑	❑	❑	❑

Unrelated Memorising Sub-scale

	SA	A	U	D	SD
00. I find I have to concentrate on just memorising a good deal of what I have to learn.	❑	❑	❑	❑	❑
00. Much of what I'm studying makes little sense, it's like unrelated bits and pieces.	❑	❑	❑	❑	❑
00. I'm not really sure what's important in lectures, so I try to get down all I can.	❑	❑	❑	❑	❑
00. I often have trouble making sense of things I have to remember.	❑	❑	❑	❑	❑

Syllabus-boundness Sub-scale

	SA	A	U	D	SD
00. I tend to read very little beyond what is actually required to pass.	❑	❑	❑	❑	❑
00. I concentrate on learning just those bits of information I have to know to pass.	❑	❑	❑	❑	❑

00. I gear my studying closely to just what seems to be required for assignments and exams. SA ❑ A ❑ U ❑ D ❑ SD ❑

00. I like to be told precisely what to do in essays or other assignments SA ❑ A ❑ U ❑ D ❑ SD ❑

B. Preferences for Different Types of Course and Teaching

Please indicate your preferences for different types of course and teaching by ticking the appropriate box next to each statement below. Only choose Unsure (U) if you feel certain that you cannot provide a definite answer either way.

***DL** = Definitely Like **L** = Like Somewhat **U** = Unsure **D** = Dislike **DD** = Definitely Dislike*

	DL	L	U	D	DD
37. Lecturers who tell us exactly what to put down in our notes.	❑	❑	❑	❑	❑
38. Lecturers who encourage us to think for ourselves and show us how they themselves think.	❑	❑	❑	❑	❑
39. Exams which allow me to show that I've thought about the course material for myself.	❑	❑	❑	❑	❑
40. Exams or tests which need only the material provided in our lecture notes.	❑	❑	❑	❑	❑
41. Courses in which it's made very clear just what books we have to read.	❑	❑	❑	❑	❑
42. Courses where we're encouraged to read around the subject area a lot for ourselves.	❑	❑	❑	❑	❑
43. Books which challenge you and provide explanations which go beyond the lectures.	❑	❑	❑	❑	❑
44. Books which give you definite facts and information which can be easily learned.	❑	❑	❑	❑	❑

C. Computer Literacy and Educational Experience

45. Please rate your level of computer literacy in each of the following areas:

	Expert	Skilled	Intermediate	Limited	Zero
Wordprocessing	☐	☐	☐	☐	☐
Using Windows 3.1	☐	☐	☐	☐	☐
Using Windows 95/98	☐	☐	☐	☐	☐
Information searching using online/CD-ROM databases	☐	☐	☐	☐	☐
Using educational software (e.g. teach yourself/class-based tools)	☐	☐	☐	☐	☐

46. Please rate your level of internet literacy in each of the following areas:

	Expert	Skilled	Intermediate	Limited	Zero
Using a WWW browser (e.g. Netscape, Explorer)	☐	☐	☐	☐	☐
Using a WWW search engine (e.g. AltaVista, Yahoo)	☐	☐	☐	☐	☐
Using E-mail for sending and receiving messages	☐	☐	☐	☐	☐
Using online discussion facilities (e.g. newsgroups, bulletin boards)	☐	☐	☐	☐	☐

47. Please indicate any ways in which you have used the internet as part of a formal educational course (tick all that apply):

- Accessing course materials located on the WWW ☐
- Searching the WWW for information/further reading material ☐
- Using e-mail to communicate with tutors ☐
- Using e-mail to communicate with fellow students ☐
- Using a newsgroup/bulletin board facility for online discussion ☐
- Other(s) (if any, please state) ____________________

48. Please describe briefly how you feel (e.g positive, negative, apprehensive) about undertaking web-based learning.

____

____

____

49. Have you ever undertaken a supervised course of independent study (e.g. distance or open learning)? **Yes** ☐ **No** ☐

50. Prior to QMC had you ever studied at further/higher educational level (e.g HNC, HND, degree courses)? **Yes** ☐ **No** ☐

51. Did you begin studying at QMC straight from secondary school/sixth form college? **Yes** ☐ **No** ☐

D. Information About Yourself

52. Please indicate your gender.

Male ☐
Female ☐

53. Please indicate which age category you fall into.

Under 21 ☐
21 - 30 ☐
31 - 40 ☐
41 - 50 ☐
51 - 60 ☐
61 + ☐

54. Please state your name *(print in block capitals).* ______________________________

Your name is required so that all the data you provide during this study can be analysed as if it were the result of one large survey. Your identity will not be revealed in the final thesis nor in any related publications. Thank you for you cooperation.

APPROACHES TO STUDYING INVENTORY

NB: SHOWN IN LANDSCAPE TO FIT MARGINS OF THIS TRANSCRIPT

Marking scheme for ASSIST
Approaches and Study Skills Inventory for Students
(1998c)

A. What is learning?

Based on the conceptions of learning described by Marton & Saljo (1997). The categories can be seen as a hierarchy, although not all the steps or categories are generally agreed. The first three, to a decreasing extent, tend to relate to an apathetioc surface approach and can therefore be combined to indicate a conception of learning as reproducing knowledge, while the remaining three cover a view of learning involving personal understanding and development.

c. Building up knowledge by acquiring facts and information.

a. Making sure you remember things well.

d Being able to use the information you've acquired.

e. Understanding new material for yourself.

f. Seeing things in a different and more meaningful way.

b. Developing as a person.

B. Reasons for entering higher education

*These items are based on the reasons for taking course which Beaty et al. (1996) have described.
Scores can be combined to create scores on extrinsic and intrinsic interest in the course.*

Intrinsic interest *(usually related to a deep approach to studying)*

Vocational	b. The course should help me develop knowledge and skills which would be useful later on.
Academic	d. I should be able to study the subject in depth, and take interesting and stimulating courses.
Personal	g. I wanted a chance to develop as a person, broaden my horizons, and face new challenges.

Extrinsic interest *(usually related to an instrumental approach to studying)*

Vocational	a. The qualification at the end of the course should enable me to get a good job when I finish.
Academic	e. Having done well at school, it seemed to be the natural thing to go into higher education.
Personal	j. I wanted to prove to myself that I could do it.
Social	h. The opportunities for an active social life and/or sport attracted me.

No clear goals *(usually related to extrinsic interest and an instrumental approach to studying)*

c. It will give me another three or four years to decide what I really want to do later on.

f. I rather drifted into higher education without deciding it was really what I wanted to do.

i. I suppose it was a mixture of other people's expectations and no obvious alternative.

C. Approaches to Studying

Approaches to Studying derive from Marton & Saljo's (1976) ideas on approaches to learning, combined with Entwistle & Ramsden's (1983) descriptions on a startegic approach to studying. The first three sub-scales in each approach are most consistently related to each other, and can be combined with confidence. Subsequent sub-scales are more likely to vary in their relationships across different samples. Relationships thus need to be checked in the particular sample used for the study.

Deep Approach

Seeking meaning

4. I usually set out to understand for myself the meaning of what we have to learn.

17. When I'm reading an article or book, I try to find out for myself exactly what the author means.

30. When I am reading I stop from time to time to reflect on what I am trying to learn from it.

43. Before tackling a problem or assignment, I first try to work out what lies behind it.

Relating ideas

11. I try to relate ideas I come across to those in other topics or other courses whenever possible.

21. When I'm working on a new topic, I try to see in my own mind how all the ideas fit together.

33 Ideas in course books or articles often set me off on long chains of thought of my own.

46. I like to play around with ideas of my own even if they don't get me very far.

Use of evidence

9 I look at the evidence carefully and try to reach my own conclusion about what I'm studying.

23. Often I find myself questioning things I hear in lectures or read in books.

36. When I read, I examine the details carefully to see how they fit in with what's being said.

49. It's important for me to be able to follow the argument, or to see the reason behind things.

Related sub-scale

Interest in ideas

13. Regularly I find myself thinking about ideas from lectures when I'm doing other things.
26. I find that studying academic topics can be quite exciting at times.
39. Some of the ideas I come across on the course I find really gripping.
52. I sometimes get 'hooked' on academic topics and feel I would like to keep on studying them.

Strategic approach

Organised studying

1. I manage to find conditions for studying which allow me to get on with my work easily.
14. I think I'm quite systematic and organised when it comes to revising for exams.
27. I'm good at following up some of the reading suggested by lecturers or tutors.
40. I usually plan out my week's work in advance, either on paper or in my head.

Time management

5. I organise my study time carefully to make the best use of it.
18. I'm pretty good at getting down to work whenever I need to.
31. I work steadily through the term or semester, rather than leave it all until the last minute.
44. I generally make good use of my time during the day.

Alertness to assessment demands

2. When working on an assignment, I'm keeping in mind how best to impress the marker.

15. I look carefully at tutors' comments on course work to see how to get higher marks next time.

28. I keep in mind who is going to mark an assignment and what they're likely to be looking for.

41. I keep an eye open for what lecturers seem to think is important and concentrate on that.

Related subscales

Achieving

10. It's important to me to feel that I'm doing as well as I really can on the courses here.

24. I feel that I'm getting on well, and this helps me put more effort into the work.

37. I put a lot of effort into studying because I'm determined to do well.

50. I don't find it at all difficult to motivate myself.

Monitoring effectiveness

7. I go over the work I've done carefully to check the reasoning and that it makes sense.

20 I think about what I want to get out of this course to keep my studying well focused.

34. Before starting work on an assignment or exam question, I think first how best to tackle it.

47. When I have finished a piece of work, I check it through to see if it really meets the requirements.

Surface Apathetic Approach

Lack of purpose

3. Often I find myself wondering whether the work I am doing here is really worthwhile.
16. There's not much of the work here that I find interesting or relevant.
29. When I look back, I sometimes wonder why I ever decided to come here.
42. I'm not really interested in this course, but I have to take it for other reasons.

Unrelated memorising

6. I find I have to concentrate on just memorising a good deal of what I have to learn.
19. Much of what I'm studying makes little sense: it's like unrelated bits and pieces.
32. I'm not really sure what's important in lectures, so I try to get down all I can.
45. I often have trouble in making sense of the things I have to remember.

Syllabus-boundness

12. I tend to read very little beyond what is actually required to pass.
25. I concentrate on learning just those bits of information I have to know to pass.
38. I gear my studying closely to just what seems to be required for assignments and exams.
51. I like to be told precisely what to do in essays or other assignments.

Related motives

Fear of failure

8. Often I feel I'm drowning in the sheer amount of material we're having to cope with.
22. I often worry about whether I'll ever be able to cope with the work properly.
35. I often seem to panic if I get behind with my work.
48. Often I lie awake worrying about work I think I won't be able to do.

G. Preferences for different types of course and teaching

Supporting understanding *(related to a deep approach)*

b. - lecturers who encourage us to think for ourselves and show us how they themselves think.

c. - exams which allow me to show that I've thought about the course material for myself.

f. - courses where we're encouraged to read around the subject a lot for ourselves.

g. - books which challenge you and provide explanations which go beyond the lectures.

Transmitting information *(related to a surface approach)*

a. - lecturers who tell us exactly what to put down in our notes.

d. - exams or tests which need only the material provided in our lecture notes.

e. - courses in which it's made very clear just which books we have to read.

h. - books which give you definite facts and information which can easily be learned.

POST EXPERIENCE QUESTIONNAIRE

(EXAMPLE FROM EXPERIMENTAL STUDY)

NB: SHOWN IN LANDSCAPE TO FIT MARGINS OF THIS TRANSCRIPT

This questionnaire focuses on your experiences of web-based learning using the Colour in Computer Graphics (CCG) Website, and your opinions regarding the value of the website as an educational resource. Please read all questions carefully before responding truthfully. Seal the completed questionnaire in the envelope provided and deposit it in the box outside the CIS department office labeled 'Web-based Learning Experiment: Completed Questionnaires'.

A. General Access to CCG Website

1. Please indicate where you most frequently accessed the CCG Website from *(tick one box only)*:

   From within QMC ☐

   From home/outwith QMC ☐

2. How much time, on average, did you spend reading the CCG Website materials during each week of the study?

   Under 1.5 hours ☐

   More than 1.5 hours but less than 3 hours ☐

   More than 3 hours but less than 4.5 hours ☐

   More than 4.5 hours but less than 6 hours ☐

   More than 6 hours ☐

3. Which of the following best describes how you interacted with the CCG Website materials *(tick one box only)*?

   I only ever read the material when I was online ☐

   I read the material when I was online, and also printed out paper copies to read ☐

   I briefly scanned the material when I was online, but printed out paper copies to read properly ☐

   I never read or scanned the material when I was online, and always printed out paper copies to read ☐

   Other (if any, please state) ____________________

4. If you read <u>or</u> scanned the materials when online, please indicate any reason(s) you had for doing so *(tick all that apply)*:

- Immediate access to e-mail for contacting the tutor if and as necessary ☐
- Immediate access to the Discussion Area if and as necessary ☐
- Immediate access to the World Wide Web if and as necessary ☐
- Immediate access to other materials within the website if and as necessary ☐
- To determine which materials were worth printing out to read properly ☐
- For proper viewing of the graphical images ☐
- Other (if any, please state) ____________________

5. If you read <u>or</u> kept paper copies of the materials, please indicate any reason(s) you had for doing so *(tick all that apply)*:

- I kept paper copies of the materials as a general back-up ☐
- I prefer reading from paper to reading from a computer screen ☐
- Working with paper copies of the materials allowed me to underline passages/make annotations ☐
- Working with paper copies of the materials meant that I was not restricted to the times I could access a PC ☐
- I find that the IT Centre is not a good environment to work in ☐
- Other (if any, please state) ____________________

B. Intended Purpose of the CCG Website

The following statements relate to what you personally regarded as the intended purpose of the CCG Website. There are no right or wrong answers, so please respond truthfully. Indicate the extent to which you agree or disagree with each statement by ticking the appropriate box, only choosing Unsure (U) if you feel certain that you can neither agree or disagree.

***SA** = Strongly Agree **A** = Agree **U** = Unsure **D** = Disagree **SD** = Strongly Disagree*

	SA	A	U	D	SD
1. As a means for the distribution of study materials.	❑	❑	❑	❑	❑
2. To take advantage of the WWW as a resource for information search and retrieval.	❑	❑	❑	❑	❑
3. Providing the materials to be studied alongside the channels for subject-related discussion.	❑	❑	❑	❑	❑
4. To support independent and self-paced learning.	❑	❑	❑	❑	❑
5. Providing study materials that are more interactive than paper would allow for.	❑	❑	❑	❑	❑
6. To support the development of skill in using the internet and WWW.	❑	❑	❑	❑	❑

C. Educational Value of the CCG Website: Opinions and Experiences

Please indicate the extent to which you agree or disagree with the following statements. Work through the statements quite quickly, giving your immediate response by ticking the appropriate box. Only choose Unsure (U) if you feel certain you can neither agree or disagree with a particular statement.

***SA** = Strongly Agree **A** = Agree **U** = Unsure **D** = Disagree **SD** = Strongly Disagree*

	SA	A	U	D	SD
1. The Glossary section provided understandable definitions of the key words and phrases.	❑	❑	❑	❑	❑
2. The Discussion Area was mainly just a place where practical activity answers were to be posted.	❑	❑	❑	❑	❑
3. Using E-mail gave me time to reflect fully upon the E-mail feedback I received from the tutor.	❑	❑	❑	❑	❑
4. Becoming motivated to learn is harder working alone via the PC than in a lecture-based course.	❑	❑	❑	❑	❑
5. If I had trouble understanding a topic I accessed the Discussion Area to see if it had been discussed.	❑	❑	❑	❑	❑
6. Without E-mail for communicating with the tutor my knowledge of the theory would be poorer.	❑	❑	❑	❑	❑
7. Single point access to study materials and communication facilities is a valuable feature of the site.	❑	❑	❑	❑	❑
8. Had I found the material harder to learn, my E-mail contact with the tutor would have increased.	❑	❑	❑	❑	❑
9. Using the Discussion Area gave me time to reflect fully upon issues raised by fellow contributors.	❑	❑	❑	❑	❑
10. I feel the CCG Website generally contained enough information to guide me in using the resource.	❑	❑	❑	❑	❑
11. Some of the discussions in the Discussion Area became too disorganised to follow properly.	❑	❑	❑	❑	❑

	SA	A	U	D	SD
12. The Outline section provided a clear breakdown of the work to be undertaken during each week.	❑	❑	❑	❑	❑
13. I found the lack of real-time feedback in the Discussion Area to be frustrating.	❑	❑	❑	❑	❑
14. I feel the graphical images were primarily intended to make the Theory Base visually interesting.	❑	❑	❑	❑	❑
15. Having the activities to undertake encouraged an organised approach to learning the material.	❑	❑	❑	❑	❑
16. I only really accessed the Discussion Area whenever I was undertaking the practical activities.	❑	❑	❑	❑	❑
17. The Theory Base materials provided understandable explanations of the topics presented.	❑	❑	❑	❑	❑
18. I tended not to E-mail the tutor with any subject-related queries that seemed relatively minor.	❑	❑	❑	❑	❑
19. The Discussion Area existed to enable students to discuss their answers to the practical activities.	❑	❑	❑	❑	❑
20. The Outline section provided a clear explanation of what the activities to be completed involved.	❑	❑	❑	❑	❑
21. I generally E-mailed the tutor any time I had a general query relating to the study.	❑	❑	❑	❑	❑
22. The introduction to each section of the Theory Base clearly explained what was to be learned.	❑	❑	❑	❑	❑
23. The Discussion Area contributions I responded to I chose because I had a relevant point to make.	❑	❑	❑	❑	❑
24. I found the absence of face-to-face contact with fellow students to be a significant problem.	❑	❑	❑	❑	❑
25. I generally only looked at the graphical images that struck me as being visually interesting.	❑	❑	❑	❑	❑

	SA	A	U	D	SD
26. The Discussion Area enabled a better quality of discussion than is possible in a classroom debate.	❑	❑	❑	❑	❑
27. The graphical images did not prove distracting when I was reading the text in the Theory Base.	❑	❑	❑	❑	❑
28. I would enjoy using a Discussion Area or similar facility for discussion in my formal modules.	❑	❑	❑	❑	❑
29. E-mail was an effective means of communicating with the tutor.	❑	❑	❑	❑	❑
30. Web-based learning encouraged me to be more organised in my study methods than normal.	❑	❑	❑	❑	❑
31. The idea of my Discussion Area contributions being constantly available on-screen is intimidating.	❑	❑	❑	❑	❑
32. I generally expressed myself more clearly using E-mail than I would in a face-to-face situation.	❑	❑	❑	❑	❑
33. Using E-mail gave me the time to consider my thoughts carefully before sending a message.	❑	❑	❑	❑	❑
34. My understanding of the theory would be poorer if I had not used the Discussion Area facility.	❑	❑	❑	❑	❑
35. The hyperlinks in the Theory Base allow previous topics to be easily revisited if studying online.	❑	❑	❑	❑	❑
36. E-mail is a more convenient way of contacting a tutor than attempting to meet face-to-face.	❑	❑	❑	❑	❑
37. One function of the Discussion Area was as an open platform for starting subject-related debate.	❑	❑	❑	❑	❑

	SA	A	U	D	SD
38. I feel the graphical images were intended to show how theoretical issues applied to the real world.	☐	☐	☐	☐	☐
39. I generally E-mailed the tutor any time I had difficulty understanding a topic or issue.	☐	☐	☐	☐	☐
40. Learning with the CCG site involved a feeling of isolation I do not get in lecture-based courses.	☐	☐	☐	☐	☐
41. The Discussion Area was not used as effectively for subject-related debate as it could have been.	☐	☐	☐	☐	☐
42. Students were to use E-mail to contact the tutor with any general queries relating to the study.	☐	☐	☐	☐	☐
43. The written tests would've been harder had I not seen examples of colour use in the Theory Base.	☐	☐	☐	☐	☐
44. Studying independently encouraged me to think very carefully about the subjects being learned.	☐	☐	☐	☐	☐
45. Reading Discussion Area contributions helped me to understand issues from new perspectives.	☐	☐	☐	☐	☐
46. Learning was very organised as all the materials were available in advance in one environment.	☐	☐	☐	☐	☐
47. When working online contributions to the Discussion Area can be made as soon as the idea occurs.	☐	☐	☐	☐	☐
48. The quality of the feedback I received via the tutors E-mail responses was good.	☐	☐	☐	☐	☐
49. The graphical images I looked at I only really referred to, as opposed to studying their content.	☐	☐	☐	☐	☐
50. I generally accessed the Discussion Area to read the contributions whenever I was online.	☐	☐	☐	☐	☐
51. One function of E-mail was to allow students to contact each other with any subject-related queries.	☐	☐	☐	☐	☐

	SA	A	U	D	SD
52. Some of the discussions in the Discussion Area became too long to follow properly.	☐	☐	☐	☐	☐
53. The tutor responded in good time when replying to my E-mail messages.	☐	☐	☐	☐	☐
54. I generally expressed myself more clearly in the Discuss. Area than I would in a classroom debate.	☐	☐	☐	☐	☐
55. The activities undertaken enabled me to develop skill in applying the theory that was studied.	☐	☐	☐	☐	☐
56. The Discussion Area would have benefited from increased tutor participation.	☐	☐	☐	☐	☐
57. Immediate access to E-mail to contact the tutor (eg. to ask questions) is valuable if working online.	☐	☐	☐	☐	☐
58. The graphical images were a valuable aid to understanding the textual content of the Theory Base.	☐	☐	☐	☐	☐
59. Using the Discussion Area gave me time to consider my thoughts carefully before contributing.	☐	☐	☐	☐	☐
60. Studying online enabled me to access the WWW as required to undertake the practical activities.	☐	☐	☐	☐	☐
61. I would have benefited educationally from a degree of face-to-face contact with fellow students.	☐	☐	☐	☐	☐
62. The graphical images helped me to see how the theoretical issues related to the 'real world'.	☐	☐	☐	☐	☐
63. I saw the Discussion Area as a channel for raising questions on topics I had trouble understanding.	☐	☐	☐	☐	☐
64. The CCG website enabled me to access materials and undertake learning as and when convenient.	☐	☐	☐	☐	☐
65. One function of E-mail was to allow students to contact the tutor with any subject-related queries.	☐	☐	☐	☐	☐

66. I studied any graphical images that related to a section of text that I had difficulty understanding. SA ❑ A ❑ U ❑ D ❑ SD ❑

67. As the Theory Base came complete, you do not miss important points as can happen in a lecture. SA ❑ A ❑ U ❑ D ❑ SD ❑

68. I felt more personal responsibility for my own learning than I would in a lecture-based course. SA ❑ A ❑ U ❑ D ❑ SD ❑

69. When working online I valued the instant access to whichever materials or site features I required. SA ❑ A ❑ U ❑ D ❑ SD ❑

70. Recalling the graphical images helps me to remember the topics covered in the Theory Base SA ❑ A ❑ U ❑ D ❑ SD ❑

71. I have found learning using the CCG Website to be an enjoyable educational experience. SA ❑ A ❑ U ❑ D ❑ SD ❑

72. I feel web-based learning generally requires more mental effort on the part of the learner. SA ❑ A ❑ U ❑ D ❑ SD ❑

73. Learning the Theory Base material would be less time-consuming if delivered via lectures. SA ❑ A ❑ U ❑ D ❑ SD ❑

74. The activities encouraged me to think about how the theoretical issues related to the 'real world'. SA ❑ A ❑ U ❑ D ❑ SD ❑

75. I always studied the graphical images when attempting to learn the material in the Theory Base. SA ❑ A ❑ U ❑ D ❑ SD ❑

76. Studying with the CCG site let me control the pace at which I learned the Theory Base material. SA ❑ A ❑ U ❑ D ❑ SD ❑

77. Without the graphical images the Theory Base material would have been less interesting to study. SA ❑ A ❑ U ❑ D ❑ SD ❑

78. In found the absence of face-to-face contact with the tutor to be a significant problem. SA ❑ A ❑ U ❑ D ❑ SD ❑

	SA	A	U	D	SD
79. I feel the graphical images were intended to be an integral part of the material we studied.	❑	❑	❑	❑	❑
80. I would have benefited educationally from a degree of face-to-face contact with the tutor.	❑	❑	❑	❑	❑
81. Had I not undertaken the activities my understanding of the theory we studied would be poorer.	❑	❑	❑	❑	❑
82. The graphical images were generally only there to be studied if the text proved hard to understand.	❑	❑	❑	❑	❑
83. I feel I would benefit educationally from access to web-based resources in my formal modules.	❑	❑	❑	❑	❑
84. As the Theory Base is constantly available, not being at college does not mean missing content.	❑	❑	❑	❑	❑
85. Having all the Theory Base available at once helped me form a good overview of the subject area.	❑	❑	❑	❑	❑
86. When used as the only means of course delivery, I do not feel suited to web-based learning.	❑	❑	❑	❑	❑
87. I enjoyed the increased control for my own learning that studying with the CCG site involved.	❑	❑	❑	❑	❑
88. I feel I would have learned more had the CCG material been delivered as a lecture-based course.	❑	❑	❑	❑	❑

X

D. Learning Outcome

1. Please indicate how confident you feel in your understanding of the following topics as covered in the CCG Website:

	Very Confident	Confident	Some Confidence	Little Confidence	No Confidence
Colour vision and colour perception	❑	❑	❑	❑	❑
Using colour effectively in computer displays	❑	❑	❑	❑	❑
Colour in the human-computer interface	❑	❑	❑	❑	❑

2. Please rate your level of internet literacy in each of the following areas:

	Expert	Skilled	Intermediate	Limited	Zero
Using a WWW browser	❑	❑	❑	❑	❑
Using a WWW search engine	❑	❑	❑	❑	❑
Using E-mail for sending and receiving messages	❑	❑	❑	❑	❑
Using online discussion facilities	❑	❑	❑	❑	❑

3. Please state your name *(print in block capitals).* ________________________________

Your name is required so that all the data you provide during this study can be analysed as if it were the result of one large survey. Your identity will not be revealed in the final thesis nor in any related publications. Thank you for your cooperation.

x.

APPENDIX V

POST EXPERIENCE QUESTIONNAIRE (SCALES GROUPED)

(EXAMPLE FROM EXPERIMENTAL STUDY)

NB: SHOWN IN LANDSCAPE TO FIT MARGINS OF THIS TRANSCRIPT

Web-Based Learning Experiment - Post Experience Questionnaire

This questionnaire focuses on your experiences of web-based learning using the Colour in Computer Graphics (CCG) Website, and your opinions regarding the value of the website as an educational resource. Please read all questions carefully before responding truthfully. Seal the completed questionnaire in the envelope provided and deposit it in the box outside the CIS department office labeled 'Web-based Learning Experiment: Completed Questionnaires'.

A. General Access to CCG Website

1. Please indicate where you most frequently accessed the CCG Website from *(tick one box only)*:

   - From within QMC ☐
   - From home/outwith QMC ☐

2. How much time, on average, did you spend reading the CCG Website materials during each week of the study?

   - Under 1.5 hours ☐
   - More than 1.5 hours but less than 3 hours ☐
   - More than 3 hours but less than 4.5 hours ☐
   - More than 4.5 hours but less than 6 hours ☐
   - More than 6 hours ☐

3. Which of the following best describes how you interacted with the CCG Website materials *(tick one box only)*?

   - I only ever read the material when I was online ☐
   - I read the material when I was online, and also printed out paper copies to read ☐
   - I briefly scanned the material when I was online, but printed out paper copies to read properly ☐
   - I never read or scanned the material when I was online, and always printed out paper copies to read ☐
   - Other (if any, please state) ____________________

4. If you read <u>or</u> scanned the materials when online, please indicate any reason(s) you had for doing so *(tick all that apply)*:

- Immediate access to e-mail for contacting the tutor if and as necessary ☐
- Immediate access to the Discussion Area if and as necessary ☐
- Immediate access to the World Wide Web if and as necessary ☐
- Immediate access to other materials within the website if and as necessary ☐
- To determine which materials were worth printing out to read properly ☐
- For proper viewing of the graphical images ☐
- Other (if any, please state) ______________________________

5. If you read <u>or</u> kept paper copies of the materials, please indicate any reason(s) you had for doing so *(tick all that apply)*:

- I kept paper copies of the materials as a general back-up ☐
- I prefer reading from paper to reading from a computer screen ☐
- Working with paper copies of the materials allowed me to underline passages/make annotations ☐
- Working with paper copies of the materials meant that I was not restricted to the times I could access a PC ☐
- I find that the IT Centre is not a good environment to work in ☐
- Other (if any, please state) ______________________________

B. Intended Purpose of the CCG Website

The following statements relate to what you personally regarded as the intended purpose of the CCG Website. There are no right or wrong answers, so please respond truthfully. Indicate the extent to which you agree or disagree with each statement by ticking the appropriate box, only choosing Unsure (U) if you feel certain that you can neither agree or disagree.

***SA** = Strongly Agree **A** = Agree **U** = Unsure **D** = Disagree **SD** = Strongly Disagree*

	SA	A	U	D	SD
1. As a means for the distribution of study materials.	☐	☐	☐	☐	☐
2. To take advantage of the WWW as a resource for information search and retrieval.	☐	☐	☐	☐	☐
3. Providing the materials to be studied alongside the channels for subject-related discussion.	☐	☐	☐	☐	☐
4. To support independent and self-paced learning.	☐	☐	☐	☐	☐
5. Providing study materials that are more interactive than paper would allow for.	☐	☐	☐	☐	☐
6. To support the development of skill in using the internet and WWW.	☐	☐	☐	☐	☐

C. Educational Value of the CCG Website: Opinions and Experiences

Please indicate the extent to which you agree or disagree with the following statements. Work through the statements quite quickly, giving your immediate response by ticking the appropriate box. Only choose Unsure (U) if you feel certain you can neither agree or disagree with a particular statement.

***SA** = Strongly Agree **A** = Agree **U** = Unsure **D** = Disagree **SD** = Strongly Disagree*

'Pedagogical Value of Materials' Scale

	SA	A	U	D	SD
00. The Theory Base materials provided understandable explanations of the topics presented.	☐	☐	☐	☐	☐
00. The Glossary section provided understandable definitions of the key words and phrases.	☐	☐	☐	☐	☐
00. The Outline section provided a clear breakdown of the work to be undertaken during each week.	☐	☐	☐	☐	☐
00. The Outline section provided a clear explanation of what the activities to be completed involved.	☐	☐	☐	☐	☐
00. The introduction to each section of the Theory Base clearly explained what was to be learned.	☐	☐	☐	☐	☐
00. I feel the CCG Website generally contained enough information to guide me in using the resource.	☐	☐	☐	☐	☐

'Discussion Area Purpose' Scale

	SA	A	U	D	SD
00. The Discussion Area existed to enable students to discuss their answers to the practical activities	☐	☐	☐	☐	☐
00. One function of the Discussion Area was as an open platform for starting subject-related debate.	☐	☐	☐	☐	☐
00. The Discussion Area was mainly just a place where practical activity answers were to be posted.	☐	☐	☐	☐	☐
00. I saw the Discussion Area as a channel for raising questions on topics I had trouble understanding.	☐	☐	☐	☐	☐

'Discussion Area Usage' Scale

	SA	A	U	D	SD
00. I only really accessed the Discussion Area whenever I was undertaking the practical activities.	☐	☐	☐	☐	☐
00. I generally accessed the Discussion Area to read the contributions whenever I was online.	☐	☐	☐	☐	☐
00. If I had trouble understanding a topic I accessed the Discussion Area to see if it had been discussed.	☐	☐	☐	☐	☐
00. The Discussion Area contributions I responded to I chose because I had a relevant point to make.	☐	☐	☐	☐	☐

'Discussion Area Value' Scale - Positive Items

	SA	A	U	D	SD
00. Using the Discussion Area gave me time to consider my thoughts carefully before contributing.	☐	☐	☐	☐	☐
00. Using the Discussion Area gave me time to reflect fully upon issues raised by fellow contributors.	☐	☐	☐	☐	☐
00. Reading Discussion Area contributions helped me to understand issues from new perspectives.	☐	☐	☐	☐	☐
00. My understanding of the theory would be poorer if I had not used the Discussion Area facility.	☐	☐	☐	☐	☐
00. I would enjoy using a Discussion Area or similar facility for discussion in my formal modules.	☐	☐	☐	☐	☐
00. The Discussion Area enabled a better quality of discussion than is possible in a classroom debate.	☐	☐	☐	☐	☐
00. I generally expressed myself more clearly in the Discuss. Area than I would in a classroom debate.	☐	☐	☐	☐	☐

'Discussion Area Value' Scale - Negative Items

	SA	A	U	D	SD
00. I found the lack of real-time feedback in the Discussion Area to be frustrating.	☐	☐	☐	☐	☐
00. The idea of my Discussion Area contributions being constantly available on-screen is intimidating.	☐	☐	☐	☐	☐
00. The Discussion Area would have benefited from increased tutor participation.	☐	☐	☐	☐	☐
00. Some of the discussions in the Discussion Area became too long to follow properly.	☐	☐	☐	☐	☐
00. Some of the discussions in the Discussion Area became too disorganised to follow properly.	☐	☐	☐	☐	☐
00. The Discussion Area was not used as effectively for subject-related debate as it could have been.	☐	☐	☐	☐	☐

'E-mail Purpose' Scale

	SA	A	U	D	SD
00. E-mail was primarily to be used as a means of posting practical activity answers to the tutor.	☐	☐	☐	☐	☐
00. One function of E-mail was to allow students to contact the tutor with any subject-related queries.	☐	☐	☐	☐	☐
00. One function of E-mail was to allow students to contact each other with any subject-related queries.	☐	☐	☐	☐	☐
00. Students were to use E-mail to contact the tutor with any general queries relating to the study.	☐	☐	☐	☐	☐

'E-mail Usage' Scale

	SA	A	U	D	SD
00. I generally E-mailed the tutor any time I had difficulty understanding a topic or issue.	❑	❑	❑	❑	❑
00. I generally E-mailed the tutor any time I had a general query relating to the study.	❑	❑	❑	❑	❑
00. Had I found the material harder to learn, my E-mail contact with the tutor would have increased	❑	❑	❑	❑	❑
00. I tended not to E-mail the tutor with any subject-related queries that seemed relatively minor.	❑	❑	❑	❑	❑

'E-mail Value' Scale

	SA	A	U	D	SD
00. The tutor responded in good time when replying to my E-mail messages.	❑	❑	❑	❑	❑
00. The quality of the feedback I received via the tutors E-mail responses was good.	❑	❑	❑	❑	❑
00. E-mail was an effective means of communicating with the tutor.	❑	❑	❑	❑	❑
00. I generally expressed myself more clearly using E-mail than I would in a face-to-face situation.	❑	❑	❑	❑	❑
00. Using E-mail gave me the time to consider my thoughts carefully before sending a message.	❑	❑	❑	❑	❑
00. Without E-mail for communicating with the tutor my understanding of the theory would be poorer.	❑	❑	❑	❑	❑
00. E-mail is a more convenient way of contacting a tutor than attempting to meet face-to-face.	❑	❑	❑	❑	❑
00. Using E-mail gave me time to reflect fully upon the E-mail feedback I received from the tutor.	❑	❑	❑	❑	❑

‘Graphics Purpose’ Scale

	SA	A	U	D	SD
00. I feel the graphical images were primarily intended to make the Theory Base visually interesting.	❑	❑	❑	❑	❑
00. The graphical images were generally only there to be studied if the text proved hard to understand.	❑	❑	❑	❑	❑
00. I feel the graphical images were intended to show how theoretical issues applied to the real world.	❑	❑	❑	❑	❑
00. I feel the graphical images were intended to be an integral part of the material we studied.	❑	❑	❑	❑	❑

‘Graphics Usage’ Scale

	SA	A	U	D	SD
00. I always studied the graphical images when attempting to learn the material in the Theory Base.	❑	❑	❑	❑	❑
00. I studied any graphical images that related to a section of text that I had difficulty understanding.	❑	❑	❑	❑	❑
00. I generally only looked at the graphical images that struck me as being visually interesting.	❑	❑	❑	❑	❑
00. The graphical images I looked at I only really referred to, as opposed to studying their content.	❑	❑	❑	❑	❑

‘Graphics Value’ Scale

	SA	A	U	D	SD
00. Recalling the graphical images helps me to remember the topics covered in the Theory Base.	❑	❑	❑	❑	❑
00. The graphical images were a valuable aid to understanding the textual content of the Theory Base.	❑	❑	❑	❑	❑
00. The written tests would’ve been harder had I not seen examples of colour use in the Theory Base.	❑	❑	❑	❑	❑

	SA	A	U	D	SD
00. The graphical images helped me to see how the theoretical issues related to the 'real world'.	❑	❑	❑	❑	❑
00. Without the graphical images the Theory Base material would have been less interesting to study.	❑	❑	❑	❑	❑
00. The graphical images did not prove distracting when I was reading the text in the Theory Base.	❑	❑	❑	❑	❑

'Integrated Environment Value' Scale

	SA	A	U	D	SD
00. Immediate access to E-mail to contact the tutor (eg. to ask a question) is valuable if working online.	❑	❑	❑	❑	❑
00. When working online I valued the instant access to whichever materials or site features I required.	❑	❑	❑	❑	❑
00. The hyperlinks in the Theory Base allow previous topics to be easily revisited if studying online.	❑	❑	❑	❑	❑
00. Single point access to study materials and communication facilities is a valuable feature of the site.	❑	❑	❑	❑	❑
00. When working online contributions to the Discussion Area can be made as soon as the idea occurs.	❑	❑	❑	❑	❑
00. Studying online enabled me to access the WWW as required to undertake the practical activities.	❑	❑	❑	❑	❑

'Mediated Materials Value' Scale

	SA	A	U	D	SD
00. The CCG website enabled me to access materials and undertake learning as and when convenient.	❑	❑	❑	❑	❑
00. Having all the Theory Base available at once helped me form a good overview of the subject area.	❑	❑	❑	❑	❑
00. As the Theory Base came complete, you do not miss important points as can happen in a lecture.	❑	❑	❑	❑	❑

	SA	A	U	D	SD
00. As the Theory Base is constantly available, not being at college does not mean missing content.	❑	❑	❑	❑	❑
00. Studying with the CCG site let me control the pace at which I learned the Theory Base material.	❑	❑	❑	❑	❑
00. Learning was very organised as all the materials were available in advance in one environment.	❑	❑	❑	❑	❑

'Changed Role of Learner' Scale

	SA	A	U	D	SD
00. I felt more personal responsibility for my own learning than I would in a lecture-based course.	❑	❑	❑	❑	❑
00. Learning the Theory Base material would be less time-consuming if delivered via lectures.	❑	❑	❑	❑	❑
00. Studying independently encouraged me to think very carefully about the subjects being learned.	❑	❑	❑	❑	❑
00. I feel web-based learning generally requires more mental effort on the part of the learner.	❑	❑	❑	❑	❑
00. Web-based learning encouraged me to be more organised in my study methods than normal.	❑	❑	❑	❑	❑
00. I enjoyed the increased control for my own learning that studying with the CCG site involved.	❑	❑	❑	❑	❑

X

'Lack of Synchronous Interaction' Scale

	SA	A	U	D	SD
00. In found the absence of face-to-face contact with the tutor to be a significant problem.	☐	☐	☐	☐	☐
00. I found the absence of face-to-face contact with fellow students to be a significant problem.	☐	☐	☐	☐	☐
00. Learning with the CCG site involved a feeling of isolation I do not get in lecture-based courses.	☐	☐	☐	☐	☐
00. Becoming motivated to learn is harder working alone via the PC than in a lecture-based course.	☐	☐	☐	☐	☐
00. I would have benefited educationally from a degree of face-to-face contact with fellow students.	☐	☐	☐	☐	☐
00. I would have benefited educationally from a degree of face-to-face contact with the tutor.	☐	☐	☐	☐	☐

'Learning Activities Value' Scale

	SA	A	U	D	SD
00. The activities undertaken enabled me to develop skill in applying the theory that was studied.	☐	☐	☐	☐	☐
00. The activities encouraged me to think about how the theoretical issues related to the 'real world'.	☐	☐	☐	☐	☐
00. Had I not undertaken the activities my understanding of the theory we studied would be poorer.	☐	☐	☐	☐	☐
00. Having the activities to undertake encouraged an organised approach to learning the material.	☐	☐	☐	☐	☐

'Networked Learning Value' Scale

	SA	A	U	D	SD
00. I have found learning using the CCG Website to be an enjoyable educational experience.	☐	☐	☐	☐	☐
00. When used as the only means of course delivery, I do not feel suited to web-based learning.	☐	☐	☐	☐	☐

	SA	A	U	D	SD
00. I feel I would benefit educationally from access to web-based resources in my formal modules.	❑	❑	❑	❑	❑
00. I feel I would have learned more had the CCG material been delivered as a lecture-based course.	❑	❑	❑	❑	❑

D. Learning Outcomes

1. Please indicate how confident you feel in your understanding of the following topics as covered in the CCG Website:

	Very Confident	Confident	Some Confidence	Little Confidence	No Confidence
Colour vision and colour perception	❑	❑	❑	❑	❑
Using colour effectively in computer displays	❑	❑	❑	❑	❑
Colour in the human-computer interface	❑	❑	❑	❑	❑

2. Please rate your level of internet literacy in each of the following areas:

	Expert	Skilled	Intermediate	Limited	Zero
Using a WWW browser	❑	❑	❑	❑	❑
Using a WWW search engine	❑	❑	❑	❑	❑
Using E-mail for sending and receiving messages	❑	❑	❑	❑	❑
Using online discussion facilities	❑	❑	❑	❑	❑

3. Please state your name *(print in block capitals).* ____________________

Your name is required so that all the data you provide during this study can be analysed as if it were the result of one large survey. Your identity will not be revealed in the final thesis nor in any related publications. Thank you for you cooperation.

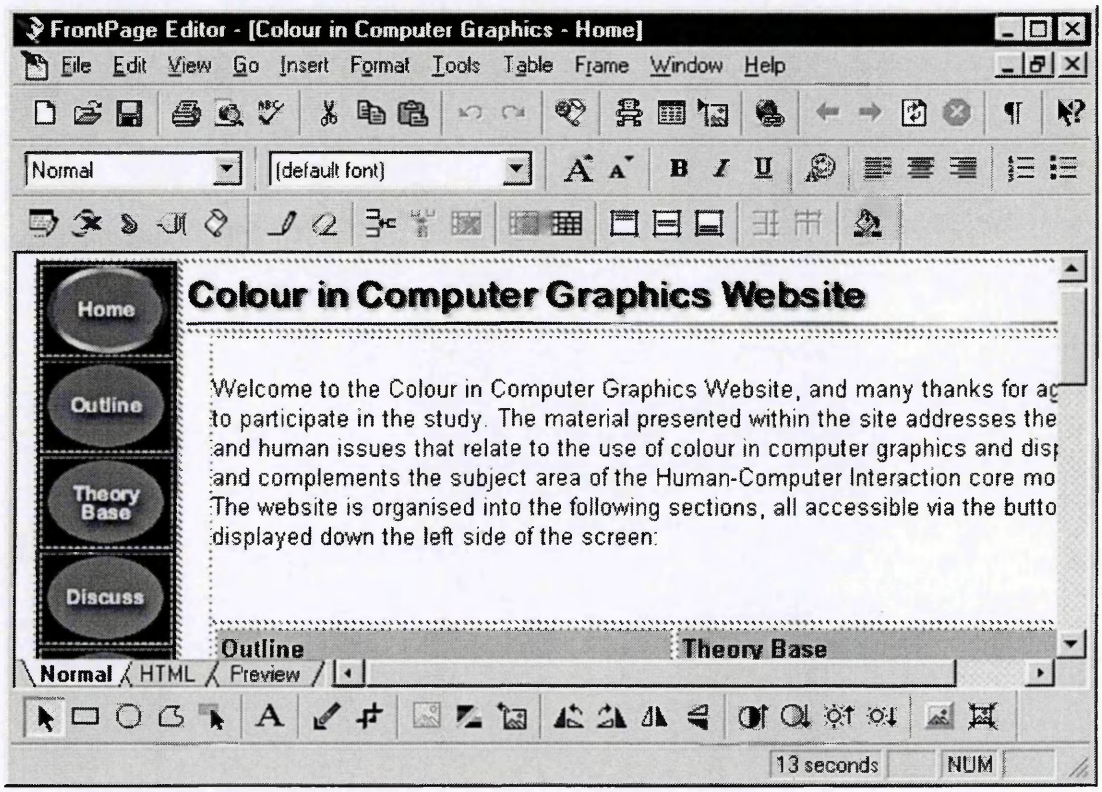
EXAMPLE OF PERIODIC KNOWLEDGE TEST

(FROM EXPERIMENTAL STUDY)

Web-based Learning Study: Short Knowledge Test 3A

The following image adheres to many of the design principles you studied in section 3 of the Theory Base, Colour in the Human-Computer Interface. Study the image and then answer the question that follows. Please write your answer on the sheet provided.

<u>Image: Website Design Application</u>
The interface for this website design application is mid-grey in colour and surrounds the main display area in which the website being designed appears. The interface contains a number of toolbars which are located at the top and bottom of the screen. The icons in the toolbars represent many command options, some of which are common to all Windows applications and others which are particular to this specialist application. Colour is used minimally within the interface, limited mainly to the design of the icons.



<u>Question:</u> Making reference where appropriate to the above, explain what you understand about (a) the purpose of human-computer interfaces and how colour should be used in their design, including icon design (b) colour vision deficiency and the measures that should be taken to ensure interfaces and displays can be interpreted by all users, and (c) why it is acceptable for expert applications to have more complex interfaces than common applications, describing also how colour should be used in expert application interfaces.

Web-based Learning Experiment: Short Knowledge Test 3B

Each of the following questions relates to a topic covered in section 3 of the Theory Base, Colour in the Human-Computer Interface. Please read each question carefully, and indicate what you believe to be the correct answer by circling the relevant letter.

Name (please print in block capitals) ______________________________

01. Approximately what percentage of the Caucasian adult male population are colour vision deficient?

A. 10%
B. 8%
C. 12%
D. 1%

02. Which form of colour vision deficiency is caused by absence of the red pigment in the eye's cone cells?

A. Tritanopia
B. Protanopia
C. Dueteranopia
D. Retanopia

03. The minimum acceptable level of luminance contrast between foreground and background colour is:

A. 5:1
B. 3:1
C. 10:1
D. 7:1

04. Which one of the following is not one of the four colours that are less likely to be confused with other colours?

A. Black
B. Yellow
C. Brown
D. White

05. Which one of the following features a 'display-embedded' interface?

A. The Netscape web-browser application
B. Cash dispenser operated via push-buttons surrounding the display screen
C. The Colour in Computer Graphics Website
D. Microsoft Word wordprocessing application

06. Which one of the following combinations produces unpleasant visual 'vibrations' when used within blocks of text?

A. Yellow against dark blue
B. Black against mid-grey
C. Green against blue
D. Dark blue against white

07. The general term for an individual suffering from the most common form of colour-vision deficiency is:

A. Deteromoid
B. Deteromat
C. Dichromoid
D. Dichromat

08. In the design of effective icons the two most important factors are:

A. Tone and colour
B. Line and form
C. Tone and form
D. Line and colour

09. Which one of the following would be expected to feature the most complex interface?

A. A database application
B. A graphic design application
C. A spreadsheet application
D. A web browser application

10. If an individual has 'atypical' colour blindness they:

A. Are unable to discriminate between any colours
B. Are only able to perceive different shades of one specific colour
C. Are only able to perceive very clear colours
D. Are unable to discriminate between black and white

USAGE LOG

(EXAMPLE FROM CARBOHYDRATE CHEMISTRY CASE STUDY)

NB: SHOWS COVER SHEET AND LOG FOR ONE CALENDAR WEEK

CVU Carbohydrate Chemistry Web-based Learning Study - Usage Log

This usage log has been distributed as part of the study investigating web-based learning on the Carbohydrate Chemistry module, and is designed to enable you to record how you interact with the Carbohydrate Chemistry web site for the duration of the module. Inside you will find 15 identical log sheets, one for each week of the module including the two non-teaching weeks of the Christmas vacation. Each log sheet contains data entry boxes that account for two on-line sessions per college day (Mon to Fri), and additional data entry boxes to be used as required (e.g. if you access the web site more than twice on the same day).

Participant Details

On receiving this usage log please state your name below. Your name is required so that all the data you provide during this study can be analysed as if it were the result of one large survey. Your identity will not be revealed in the final thesis nor in any related publications.

Name (*please print in block capitals*): ______________________________

Please ensure you read the following instructions carefully:

1. The log sheets are designed to be completed from left to right. Each row represents one on-line session, and each column heading a feature of the web site.
2. There is one checkbox under most of the column headings. Where there are two checkboxes under a column heading the abbreviations given represent ways in which that feature of the web site may have been used. A key to the abbreviations appears at the bottom of each log sheet.
3. On each occasion you access the web site record the 'Start Time'. At the end of the session record the 'End Time', and tick the relevant boxes to indicate how you used the web site during that particular session. Alternatively you may tick the relevant boxes as you go along. Leave blank any checkboxes that do not apply.
4. Once the usage log is complete please seal in the envelope provided and return immediately. Deposit in the box located at the Departmental Office, Room C66, Thomas Graham Building.

Important

1. The usage log must be completed every time you access the web site, regardless of how you used the web site and how long the session lasted. Therefore please ensure that the usage log is available to complete during or immediately after each session. Not completing the usage log to account for each session, or completing it from memory, will result in the data collected being inaccurate and consequently the reliability of the researchers findings will be seriously compromised.
2. Each log sheet can account for 17 on-line sessions in any one week. This is to allow for situations in which a student may make particularly extensive use of the web site, and should not be interpreted as a guide to how often you should access the web site. Individual usage patterns are fully expected to vary substantially in number and duration.

Thank you for your cooperation.

Researcher: Keith Smyth, Research Student, Department of Information Management, Queen Margaret University College. E-mail: rssmyt@student.qmced.ac.uk

Complete for the week beginning: Monday 27th September

Day	Start Time	End Time	Access LB	Access HO	Introducing Carb Chem	N. Group Effects	Protecting Groups	Glycoside Chem	Chime Model(s)	Glossary	Check-point(s)	Links	E-mailed Tutor	Chat RE	Chat CO
Mon	______	______	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Mon	______	______	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Tues	______	______	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Tues	______	______	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Wed	______	______	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Wed	______	______	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Thu	______	______	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Thu	______	______	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Fri	______	______	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Fri	______	______	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
___	______	______	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
___	______	______	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

KEY: **LB**=Accessed from lab **HO**=Accessed from home (including halls) **RE**=Read contributions to the chat area **CO**=Contributed to the chat area.

ii

11.0 PAPERS PUBLISHED FROM THE RESEARCH TO DATE

The work has been presented at several international conferences. The initial findings from the research, and more recently the theoretical framework proposed within the thesis, have been published as peer-reviewed conference papers that were co-authored with the Director of Studies. The content-as-published for the two papers listed below respectively appears in 11.1 and 11.2.

Smyth, K. and Buckner, K. (2000) Individual approaches to studying and the affordances of interacting with networked learning environments. In M. Asensio, J. Foster, V. Hodgson & D. McConnell (Eds.), *Networked Learning 2000: Innovative approaches to lifelong learning and higher education through the internet*. Lancaster University and The University of Sheffield, pp. 315-322.

Smyth, K. and Buckner, K. (2004) Towards a theoretical framework for understanding the nature of networked learning. *Proceedings of the 2004 European Conference on eLearning,* Universite Paris Dauphine, Paris, 25th – 26th November. Academic Conferences International, pp. 375-386

11.1 SMYTH, K. AND BUCKNER, K. (2000) INDIVIDUAL APPROACHES TO STUDYING AND THE AFFORDANCES OF INTERACTING WITH NETWORKED LEARNING ENVIRONMENTS

Individual Approaches to Studying and the Affordances of Interacting with Networked Learning Environments

Keith Smyth and Kathy Buckner
Department of Information Management, Faculty of Arts
Queen Margaret University College, Edinburgh

Abstract

This paper presents the general results of an investigation into networked learning via autonomously accessible, integrated environments which focused on individual approaches to studying, learning outcomes, and subjective descriptions of experience. Learners orientated towards understanding and possessing organised study methods performed most effectively, successfully acting upon the affordances of the environments. The implications are discussed.

Introduction

In recent years the basic concept of affordances that is central to the theory of the perceptual psychologist James Gibson has been adopted by an increasing number of theorists and researchers seeking to understand and explain the potential of educational technology to support and facilitate effective student learning. Gibson defined the term 'affordance' to describe the relationship between an individual and the perceived value of objects in their environment, thus a chair is seen to 'afford' support for sitting down (1979). In the context of educational technology we think of an affordance as being the opportunity for action and extended learner capabilities perceived in the properties of a specific technology or media (Ryder & Wilson, 1996).

A Networked Learning Environment (NLE) is an autonomously accessible hypertext-based resource that combines comprehensive course material with computer-mediated channels for student-student or student-tutor communication and, frequently, multimedia content. Contemporary theory in the broad constructivist tradition claims manifold affordances for students interacting with NLEs and their constituent elements. These affordances are seen to include self-paced and reflective learning (Hiltz, 1994; Grabinger & Dunlap, 1995), the appropriation of conceptually rich knowledge via exploration of conceptually rich hypertexts (Jacobson & Spiro, 1995, Jonassen et al., 1997), authentic representation of information within multiple media formats (CTGV, 1993; Jonassen et al., 1996), and the critical multi-perspective negotiation of understanding that can be fostered by effective asynchronous computer-mediated discussion (Mason, 1994; Yakimovicz & Murphy, 1995). In general terms, the rationale for having students interact with NLEs is the facilitation of an active, learner-centered educational experience that immerses the learner in the personal construction of meaning as opposed to the passive acquisition of knowledge for short-term application.

However, the potential for NLEs to enable active, effective learning can only be fully realised if the learner recognises and acts upon the affordances of the technology. Yet what guarantee do we have that each learner will interact effectively with NLEs under autonomous conditions, fully utilising and benefiting from self-paced study of mediated course material, multimedia representations of information, and the opportunity to participate in asynchronous discussion? Furthermore, what do we understand about the subjective experience of networked learning from the perspective of the learners themselves, or of the factors intrinsic to both the learner and the NLE that influence interaction and subsequent learning outcomes?

Unfortunately current research provides little insight into such issues. Studies of learning involving hypermedia have tended to be highly experimental in nature, based upon controlled interaction with stand-alone environments not autonomous interaction with integrated networked environments. Regarding the nature of the networked learning experience, an over - reliance on anecdotal descriptions of practice by educators at the expense of methodological investigation into student practice, perception and knowledge gained has been recognised (Windschitl, 1998; Ward & Newlands, 1998). The research reported within this paper was conducted to address these shortcomings on a modest scale, and provide an insight into the relationship between individual learners, subjective experience, and the affordances of NLEs.

Method

The research comprised a naturalistic experiment and case study, both of which involved undergraduate information management students (n=30) interacting with NLEs as the sole method of campus-based course delivery. Students were required to autonomously learn the mediated material, participate in on-line discussion, and complete small-scale assignments.

Semi-structured interviews with each student were the primary method of data collection and explored individual accounts of interaction, perceptions of how the NLEs and their constituent elements were intended to and did support learning, and feelings regarding personal suitability to networked learning as a mode of course delivery. To provide further insight into the latter issue and identify any possible relationship with existing learner traits, a short-form version of the Approaches to Studying Inventory (ASI) enabled students to indicate how they undertook learning on their conventional undergraduate courses (Tait et al., 1997). The ASI is grounded within the phenomenographic tradition of educational research (Entwistle & Ramsden, 1983; Marton et al., 1997), and measures whether an individual takes a deep, strategic or surface approach to learning based upon an accumulation of scores on several sub-scales representing the traits generally associated with each specific approach.

To directly assess the potential influence of individual approaches to networked learning upon subsequent learning outcomes, the experimental study facilitated naturalistic conditions through pre-selecting a group of students (n=20) to interact with a networked environment designed to complement a core module yet to be undertaken. This allowed a degree of control over prior knowledge, and ensured the mediated material to be learned was academically relevant to each individual. Students periodically completed short written tests designed to elicit a demonstration of any conceptual knowledge gained, the responses to which were analysed using the SOLO taxonomy (Biggs & Collis, 1984). The SOLO taxonomy enables the classification of learning outcomes at increasingly complex levels of conceptual understanding from a position of meaninglessness to one of abstract thought. Learning outcomes as measured by the SOLO taxonomy have been found to correlate closely with the individual approaches to studying that are measured by the ASI (Van Rossum & Schenk, 1984; Boulton-Lewis, 1998).

Approaches to Studying and Networked Learning

The relationship between individual traits, patterns of interaction and outcomes of learning with educational hypermedia is not fully understood. Whilst some studies report a correlation between these factors (e.g. Rasmussen & Davidson-Shivers, 1998; Chuang, 1999), others report no significant findings regarding learning style and outcome (Fitzgerald & Semaru, 1998). Dillon and Gabbard's (1998) recent meta-analysis further demonstrates our current lack of understanding, but does provide evidence to suggest that individuals who might be considered 'high-ability' or 'independent' learners perform most effectively with hypermedia. If this is accepted, then it would seem reasonable to assume that those individuals who indicated an orientation towards conceptual understanding or an organised approach to learning as measured via the ASI would prove to be efficient in a networked learning context.

Table 1: ASI Mean Scores with Lowest and Highest Individual Scores

Student n=30	Mean Score	Low Score	High Score
Deep Approach	**14.4**	**10**	**18**
Seeking meaning	14.3	8	18
Relating ideas	13.9	8	20
Use of evidence	15.0	10	18

Strategic Approach	**14.1**	**9**	**18**
Organised studying	13.6	8	19
Time management	13.0	6	19
Alertness to assessment demands	15.6	10	19
Surface Approach	**11.0**	**6**	**15**
Lack of purpose	8.3	4	13
Unrelated memorising	11.4	7	16
Syllabus-boundness	13.4	6	20

Range for scores on sub-scales = 4 to 20. Scores on each approach therefore range from 12 to 60, but have been expressed above as an accumulated average of the related sub-scale scores.

The mean scores on deep, strategic and surface approaches to studying and related sub-scales can be seen in Table 1, which also includes an indication of the variation in individual scores. Because the ASI was designed to assess approaches to learning on conventional courses it is inherently problematic as a direct measure within networked or hypermedia-based learning. However, the findings of this study did indicate a relationship between responses to the ASI at main scale and sub-scale level, and the way in which individual students described their approach to networked learning. The contrasting approaches to networked learning described ran on a continuum from passivity to pro-active interaction with the environment. The former extreme was characterised by disorganised autonomous study methods and an orientation towards rote learning, and the latter by highly organised autonomous study methods and an orientation towards understanding the mediated material. These contrasting positions are encapsulated within the following interview extracts, which are also indicative of the relationship between individual approaches to conventional and networked learning:

> "I do work well alone. It's a way that I like to work and I'm reasonably good at setting deadlines for myself...I tended to do it twice a week, usually at the beginning of a week and then at the end of the week for a shorter time before the test...I tried to pick out the most important things and see what's going to come up because it's a good way to work through it, it puts the points in your head...and if I didn't remember just go back and try and fill in the gaps...If you wanted to, you could just use a search engine to find similar or more [material]."

> "I sort of learnt stuff and memorised it for the test, and then just forgot it again. Just trying to cram it, yeah. I do that for exams...See, that's me. I'm just basic. I don't do any further reading or anything... I just kept reading it again. I'd do it a couple of times before coming in."

The first quotation is from a learner who scored highly on deep and strategic approach scales within the ASI, the second from a surface learner with low 'time management' and 'organised study methods' sub-scale scores. Each is describing how they approached learning the mediated material between the periodic knowledge tests administered during the experimental study. Although these comments are illustrative of extremes in approaches to networked learning, it was generally found that those students who described themselves as independent, self-motivating learners with an orientation towards conceptual understanding interacted most effectively with the NLEs. These individuals studied the mediated material in an organised, reflective manner, and fully utilised constituent elements of the NLEs through purposefully attempting to learn from the supporting multimedia components and regularly accessing asynchronous discussion facilities to read and contribute to on-line debate. In contrast, students who described themselves as disorganised, lacking motivation and with a tendency to 'cram' undertook networked learning in a 'just in time' manner, interacting with the NLEs to access the mediated material immediately prior to task deadlines which reduced the scope for reflection, interaction with multimedia components and participation in asynchronous debate.

What these findings confirm, in accordance with existing research, is that learning style or approach is to some measurable extent a factor in determining the efficiency with which an individual interacts with hypermedia-based environments. Within this study individual approaches to learning as measured by the ASI, and approaches to networked learning as described within the subjective accounts of students, provide a feasible explanation as to why only certain learners interact with networked environments in a manner conducive to the reflective, self-paced learning that asynchronous environments can facilitate (Hiltz, 1994).

Networked Learning Outcomes

Although the influence of learning style upon the effectiveness with which an individual interacts with educational hypermedia environments is accepted, the degree of influence regarding learning outcomes has hitherto been unclear (Chen & Rada, 1996; Dillon & Gabbard, 1998). As regards the findings of this study, the range of answers at increasing levels of conceptual understanding from learners who indicated a deep, strategic and surface approach to studying as measured by the ASI is shown in Table 2. No answers were classified at the extended abstract level of the SOLO taxonomy, signifying full conceptual understanding and an ability to hypothesise, possibly due to the parameters of the experiment.

Table 2: Knowledge Test Answers (SOLO) x Learning Approach and Course Preference

Student n=20	**Level 1**	**Level 2**	Trans	**Level 3**	**Trans**	**Level 4**
Deep Approach						
Support understanding *(n=3)*	1.7%	2.8%	0.0%	5.6%	2.8%	2.2%
Transmit information *(n=7)*	5.0%	10.0%	1.7%	15.6%	1.7%	1.1%
Strategic Approach						
Support understanding *(n=3)*	0.6%	1.7%	0.6%	7.2%	1.7%	3.3%
Transmit information *(n=5)*	3.3%	5.6%	0.0%	14.4%	1.7%	0.0%
Surface Approach						
Transmit information *(n=2)*	1.1%	2.8%	0.6%	5.6%	0.0%	0.0%
Total % Answers	11.7%	22.8%	2.8%	48.3%	7.8%	6.7%
Total N Answers	21	41	5	87	14	12

Level 1 = Prestructural response and in the above includes non-meaningful responses; level 2 = unistructural; level 3 = multistructural; level 4 = relational; trans = transitional. Response n=180.

Within the context of 'dominant' individual approaches to studying, the results from the knowledge tests seem at first inconclusive. The majority of responses were at the multistructural level, which is the mid-point of conceptual understanding in the SOLO taxonomy, and the number of surface learners too insignificant upon which to base any conclusions regarding the inability of these learners to answer beyond a multistructural level. The nature of these findings is possibly attributable to the potential problem of analysing approaches at main scale level as an individual may, for example, indicate that they approach learning with a focus on understanding (deep) combined with organised methods (strategic).

However, when individual approaches are differentiated by preferences for different types of course and teaching as measured by the ASI the results become more interesting. Of the 14.5% of test answers above the multistructural level at either a transitional or relational level, 10% were given by deep or strategic learners with a preference for courses which support understanding as opposed to transmitting information. This finding is perhaps more significant when considering that the individuals who provided the aforementioned 10% of answers account for only six of the eighteen learners indicating deep or strategic approaches.

The distinction between learners who prefer courses that support understanding as opposed to transmitting information would therefore seem to be a potentially important one. Presumably this is because the factors which contribute to a preference for courses that support understanding as measured via the ASI, including the opportunity for independent thinking and exposure to material that can provide explanations beyond those possible within a lecture, are also those factors central to the demands of learning via asynchronous, integrated NLEs. Evidence for this relationship was also found within learners' subjective accounts of experience. Those students taking what was earlier described as a 'passive' approach to networked learning characterised by disorganised, 'just in time' learning generally expressed a dislike for networked learning because the onus to learn was entirely upon them. Increased control over when to study was considered negative precisely because it did enable the repeated delay of

studying, and the lack of lecture-based delivery was lamented because the synchronous nature of lectures prompted attendance and therefore exposure to course content.
Students who expressed these views did not feel they learned effectively, which was generally reflected in their knowledge test responses. Learners who approached networked learning 'pro-actively' generally felt suited to this mode of course delivery and believed it to be educationally effective. Test responses consistently indicated higher levels of understanding.

Perception and Realisation of Networked Learning Affordances

To recall, an 'affordance' is the opportunity for action perceived in the properties of an educational technology or media (Martin & Ryder, 1996). If approaches to studying and preferences for different modes of course delivery influence the nature and quality of networked learning, then a logical assumption is that these factors might also influence the capacity for an individual to perceive and act upon the affordances inherent within NLEs. This issue is of critical importance, as the degree to which an individual undertakes reflective learning of mediated material, interacts with multimedia, and participates in online discussion will determine how active the networked learning experience becomes, and could subsequently either inhibit or facilitate the realisation of the potential learning outcomes.

In the subjective accounts of experience provided, a relationship between the effectiveness of individual interaction with NLEs and the perception of networked learning affordances was apparent. The following describes how one student interacted with visual multimedia:

> "Basically, there's got to have been a point to it to have been put in, that's what I think, so I keep looking at it until I get the point of why it's there, really. I did look at them all...I did actually study them to see exactly what it was trying to prove to me."

This learner perceived there to be some educational purpose to the presence of the multimedia intended to enhance the textual content of mediated material, and subsequently studied each multimedia component until they reached an understanding of the content. This approach is in contrast to that of another student who believed the multimedia was intended primarily to make the mediated material more visually interesting, and who described only looking or interacting briefly with the multimedia components as they read through the text. Such variations in perception also informed the extent to which individuals interacted with asynchronous discussion facilities, followed links to further reading material on the WWW, or attempted to learn the mediated material in an organised, reflective manner. The primary defining factor enabling successful exploitation of the affordances inherent in autonomous interaction with integrated NLEs was an acute awareness of potential educational benefits.

However, the accurate perception of affordances does not guarantee that potential educational benefits will be realised. Individual approaches to networked learning were found to limit the potential for action, especially in the case of learners who took a 'just-in-time' approach:

> "It's good having all the information there for you prepared in advance. You can look at it whenever you want [and] work at your own speed...I don't know if it worked for me. I left it all to the last minute...I could have done better if I had looked at it more...I'd be too tempted to do other things once I'd got the computer switched on."

This student demonstrated full awareness of the affordances of autonomous learning, but their own approach to learning prevented them from realising the potential benefits of self-paced study. This is illustrative of many similar comments from students who took a 'just-in-time' approach to networked learning - accessing the mediated material immediately prior to a test or work completion deadline, and generally 'cramming' within the limited time available. The fundamental problem with this approach is that it negates the opportunity for reflection, interaction with multimedia components, or participation in asynchronous discussion should the need to articulate a difficulty in understanding some aspect of the mediated material arise. For those 'passive' networked learners who did fully comprehend some or all of the affordances inherent within NLEs, the 'just-in-time' approach was often an overriding factor.

What becomes apparent in considering the relationship between individual learners and their ability to perceive and act upon the affordances of interacting with networked learning environments, and possibly any educational technology, is that it is perhaps misleading to think of affordances as being opportunities for extended learner capability there for all. In contrasting the different ways in which individuals approach networked learning it seems more appropriate to think of affordances as being inherent properties which facilitate enhanced learning potential for some, yet inhibit this for others. Beyond specific approaches to networked learning this could also apply, for example, to a student who understands the value of asynchronous discussion as a medium for reflective debate but is discouraged from contributing due to the idea of their comments being visible on-screen for scrutiny by others.

One possible reason underlying the inconsistency in the perception and realisation of networked learning affordances, and which may also apply to those students who feel their approach to studying is unsuitable to this mode of learning, is the issue of 'learning to learn'. It has been found that as meta-cognitive awareness improves so too does the ability to work effectively in a networked learning context (Hill & Hannafin, 1997). The learners in this study who took an active approach to networked learning generally indicated that they approached conventional learning in a reflective, organised manner. The likelihood is that these students already possessed the necessary meta-cognitive awareness to learn effectively. Those who approached networked learning in a passive manner tended to indicate a similar approach to conventional studying, but generally also expressed a dislike for networked learning due to what it did not afford that a traditional course did – they did not seem to fully appreciate what networked learning offered them that traditional courses do not. Perhaps as students 'learn to learn' in a networked learning context it will become more appropriate to discuss what this mode of study can universally afford all individuals, and the form of active, constructivist learning discussed in the contemporary literature will be more widely observed.

Conclusion

Within the limited parameters of this small-scale study, findings strongly suggest a relationship between individual approaches to learning and effective autonomous interaction with integrated networked environments. Directions for continuing research include further investigation into the nature of individual approaches to networked learning, and into the influence constituent NLE features have upon the mode of interaction with mediated material.

References

Biggs, J.B. , & Collis, K.F. (1982). *Evaluating the quality of learning: The SOLO taxonomy.* New York: Academic Press.

Boulton-Lewis, G. (1998). Applying the SOLO taxonomy to learning in higher education. In B. Dart & G. Boulton-Lewis (Eds.), *Teaching and learning in higher education* (pp. 201-221). ACER Press.

Chen, C. , & Rada, R. (1996). Interacting with hypertext: a meta-analysis of experimental studies. *Human-Computer Interaction, 11*, 125-156.

Chuang, Y. (1999). Teaching in a multimedia computer environment: a study of the effects of learning style, gender and math achievement. *Interactive Multimedia Journal of Computer-Enhanced Learning* [Online]. Available: http://imej.wfu.edu/articles/1999/1/10/index.asp [1999, October 10th].

CTGV (Cognition and Technology Group at Vanderbilt). (1993). Integrated media: toward a theoretical framework for utilizing their potential. *Journal of Special Education Technology, 12(2)*, 71-85.

Dillon, A. , & Gabbard, R. (1998). Hypermedia as an educational technology: a review of the quantitative research literature on learner comprehension, control, and style. *Review of Educational Research, 68*(3), 322-349.

Entwistle, N.J. , & Ramsden, P. (1983). *Understanding student learning.* London: Croom Helm.

Fitzgerald, G.E. , & Semaru, L.P. (1998). The effects of learner differences on usage patterns and learning outcomes with hypermedia case studies. *Journal of Educational Multimedia and Hypermedia, 7*(4), 309-331.

Gibson, J.J. (1979). The ecological approach to visual perception. Boston: Houghton Mifflin.

Grabinger, R.S. , & Dunlap, J.C. (1995). Rich environments for active learning: a definition. *ALT-J, 3*(2), 5-34.

Hill, J.R. , & Hannafin, M.J. (1997). Cognitive strategies and learning from the world wide web. *Educational Technology Research and Development, 4*(77), 37-64.

Hiltz, S.R. (1994). *The virtual classroom: learning without limits via computer networks.* New Jersey: Ablex.

Jacobson, M.J. , & Spiro, R.S. (1995). Hypertext learning environments, cognitive flexibility, and the transfer of complex knowledge: an empirical investigation. *Journal of Educational Computing Research, 12*(4), 301-333.

Jonassen, D.H. , Myers, J.M. , & McKillop, A.M. (1996). From constructivism to constructionism: learning with hypermedia/multimedia rather than from it. In B.G. Wilson (Ed.), *Constructivist learning environments: case studies in instructional design* (pp. 93-106). New Jersey: Educational Technology Publications.

Jonassen, D.H. , Dyer, D. , Peters, K. , Robinson, T. , Harvey, D. , King, M. , & Loughner, P. (1997). Cognitive flexibility hypertexts on the web: engaging learners in meaning making. In B.H. Khan (Ed.), *Web-based instruction* (pp. 119-133). New Jersey: Educational Technology Publications.

Marton, F. , Hounsell, D. , Entwistle, N. (Eds.), (1997). *The experience of learning: implications for teaching and studying in higher education* (2nd ed.). Edinburgh: Scottish Academic Press.

Mason, R. (1994). *Using communications media in open and flexible learning.* London: Kogan Page.

Rasmussen, K.L. , & Davidson-Shivers, G.V. (1998). Hypermedia and learning styles: can performance be influenced. *Journal of Educational Multimedia and Hypermedia, 7*(4), 291-308.

Ryder, M. , & Wilson, B. (1996). Affordances and constraints of the internet for learning and instruction. In M.R. Simonson (Ed.). *18th Annual Proceedings of Selected Research and Development Presentations at the 1996 Convention of the Association for Educational Communications and Technology* (pp. 642-654). Instructional Resource Center, Iowa State University.

Tait, H. , Entwistle, N. , & McCune, V. (1997). ASSIST: a reconceptualisation of the Approaches to Studying Inventory. Paper presented at the 5th International Improving Student Learning Symposium. University of Strathclyde.

Van Rossum, E.J. , & Schenk, S.M. (1984). The relationship between learning conception, study strategy and learning outcome. *British Journal of Educational Psychology, 54*, 73-83.

Ward, M. , & Newlands, D. (1998). Use of the web in undergraduate teaching. *Computers and Education, 31(2),* 171-184.

Windschitl, M. (1998). The WWW and classroom research: what path should we take. *Educational Researcher, 27*(1), 28-33.

Yakimovicz, A.D. , & Murphy, K.L. (1995). Constructivism and collaboration on the internet: case study of a graduate class experience. *Computers and Education, 24*(3), 203-209.

11.2 SMYTH, K. AND BUCKNER, K. (2004) TOWARDS A THEORETICAL FRAMEWORK FOR UNDERSTANDING THE NATURE OF NETWORKED LEARNING

Towards a Theoretical Framework for Understanding the Nature of Networked Learning

Keith Smyth
Academic Development Adviser
Educational Development
Napier University
k.smyth@napier.ac.uk

Kathy Buckner
Senior Lecturer
School of Computing
Napier University
k.buckner@napier.ac.uk

Abstract
This paper presents an embryonic theoretical framework that, based on original research and current understanding about the potential benefits of networked learning environments (NLEs), attempts to conceptualise the relationship between individual approaches to networked learning, the factors that affect interaction with NLEs, and networked learning outcomes.

Key words
NLEs, constructivism, student autonomy, studying approaches, learning facilitation.

1. Introduction
A Networked Learning Environment is an autonomously accessible web resource that combines hypertext course materials, online communication channels, multimedia and other interactive features. Constructivist theory makes many claims about the potential of such environments, and the educational 'affordances' inherent within them.

Yet what we understand about the ways in which students learn online, and whether this is conducive to realising networked learning benefits, is somewhat limited. Research into learning style differences and attitudes towards online studying provides a partial insight into why some students may be more effective networked learners than others, although by using psychometric tools developed for non-online contexts, and having been predominantly quantitative, it can only highlight the relevance of such factors.

As such many questions regarding the how and why of networked learning behaviour remain largely unanswered, and there is a growing consensus that an understanding informed by the subjective perspectives of learners themselves is required (Windschitl, 1998; Goodyear et al 2004). Based on a phenomenographic study sharing this concern, this paper presents a theoretical framework that attempts to consolidate the findings of the research undertaken with constructivist assumptions about learning and the affordances of educational technology.

2. Gibson's Affordances
The ecological psychologist James Gibson defined the term "affordance" to describe the relationship that exists between an individual and the opportunities for action they perceive within objects in their environment. For example, an object resting on the ground with a raised surface area at approximately knee-height can be said to afford sitting on. We might refer to a manufactured object with these properties as a chair, although the important point is that the perceivable, coexisting properties of the object "combine to yield a higher-order property for the human observer" (Gibson, 1977, p. 68).

Although affordances are inherent within objects, they are relative to individual needs. Therefore while a pen affords the opportunity for written communication, it has no immediate significance for an individual without a present need to write. This exemplifies the emergent nature of affordances, which are a fact of the environment and individual behaviour. As Gibson (1979) explained: "The observer may or may not perceive or attend to the affordance, according to his needs, but the affordance, being invariant, is always there to be perceived...The object offers what it does because it is what it is" (p. 139).

A critical point about affordances is that can be both positive and negative. Gibson used the example of a knife, which affords cutting if used appropriately, but can also afford being cut.

3. Potential Benefits of NLEs

In recent years, the basic concept of affordances has been widely adopted by educationalists, particularly constructivists, as a means for explaining the potential of computer technology to support learning (CTGV, 1993; Bell & Winn, 2000; Conole & Dyke, 2004 are among many papers that directly address Gibson's idea). In this context, the term 'affordance' is generally taken to mean the opportunity for extended learner capability that is inherent within the properties of a specific tool or resource (Ryder & Wilson, 1996).

With their single-point integrated access, NLEs are thought to be unique in how their various elements interrelate to support a full range of constructivist learning activity that would be beyond the scope of any single element, or non-networked combination of them (Miller & Miller, 2000, p. 157-158). The main affordances claimed for NLEs include:

- Studying when most conducive to learning
- Self-paced, needs-based non-linear learning via educational hypertexts, leading to a critical understanding of content (Jonassen, 1992; Jacobson & Spiro, 1995)
- More expedient understanding of phenomena, and increased likelihood of future recognition, by their presentation in realistic formats (CTGV, 1993; Mayer, 2001)
- Knowledge application and refinement through interactive tools (Bell & Winn, 2000)
- Social collaboration across temporal and geographical limitations, more equal participation in debate, and increased opportunities to reflect upon and learn from other views via asynchronous discussion (Mason, 1994; McConnell, 2000)

As well as having a theoretical basis within constructivist learning theory, there is at least a moderate amount of research evidence to support each of the above claims.

4. The Myth of the Compliant Networked Learner

Although NLEs can support learning in various ways, students do not always undertake networked learning effectively. Research into studying time distributions shows that many students only access NLEs when course deadlines are upon them (Taraban et al, 1999; Smeaton & Keogh, 1999), while much of the work that students do often occurs offline using print-outs (Crook, 1997; Ward & Newlands, 1998; Beasley & Smyth, 2004).

We also know from research into learning style differences that it is typically only the minority who can be considered amongst the more active or self-motivating that will explore hypertext material to deeper levels, or participate in online discussion to more than the required minimum (Lee & Lehman 1993; Gibbs, 1999; Light et al, 1999; Karuppan, 2001).

Goodyear (1999) referred to the "decline of the compliant learner" in observing how it is no longer reasonable to assume students will interact with educational environments in the ways their tutors intend (p. 3). Given what research tells us about student interaction with NLEs, and other hypertext or online environments, a better term might be 'the myth of the compliant learner'. This myth is perpetuated in part by constructivist theory itself, which describes how to design engaging technology-enhanced environments, but makes little attempt to account for the role the individual might play in influencing how well they actually learn from them.

5. Empirical Basis for the Framework

The research behind the proposed framework comprised a phenomenographic study focusing on the perceptions and behaviours of students who interacted with NLEs that were the sole or primary means of campus-based course delivery. Phenomenography is "the empirical study of the limited number of qualitatively different ways in which various phenomena...are experienced, conceptualised, understood, perceived, and apprehended" (Marton, 1994, p. 4424). As a method it is perhaps best known for defining deep, strategic and surface approaches to studying, which respectively reflect a need to understand, to achieve, or to reproduce knowledge (Entwistle, 2001).

The findings of the phenomenographic analysis were supplemented with data relating to assignment grades, discussion contributions, online interactions, and individual approaches to conventional studying as measured via a version of the Approaches to Studying Inventory.

Two case studies and a naturalistic experiment were conducted. The latter enabled a more controlled investigation into certain aspects of networked learning, including the influence of different NLE features upon interaction with course materials. Overall, forty-six IT-literate students from undergraduate chemistry and information management cohorts participated.

6. Approaches to Networked Learning

Through the phenomenographic interview analysis process, four themes of networked learning experience were identified. These related to how students attempted to learn from the core course materials, utilised the other constituent elements, managed their networked learning, and felt suited to studying online. Within each theme, further analysis revealed a number of categories of networked learning behaviour or attitude. Respective examples from each theme included 'focus of reading', 'interaction with supportive multimedia', 'resolving difficulty', and 'ability to study autonomously'. Through examining the qualitative differences in the descriptions relating to each category, a number of traits were identified.

The likely relationships between different traits were conceptualised, and this led to the identification of three distinct kinds of approach to networked learning (Table 1). Essentially these can be thought of as corresponding to different networked learning styles.

The classifications reflect a continuum of increasingly effective ways of undertaking networked learning, and a corresponding greater potential for realising the affordances inherent within NLEs. By applying the scheme to the accounts of experience provided, it was possible to determine the approach taken by each individual student.

Table 1: Approaches to Networked Learning and their Associated Traits

Constructive-Autonomous	Defining Traits
General characteristic: Full engagement in experience of autonomous networked learning	Concerned with developing understanding Fully pro-active interaction with NLE and features Effective time-management and self-motivation Sources knowledge from outside NLE Preference for networked instruction Confident in ability to learn autonomously via NLEs
Active-Autonomous	**Defining Traits**
General characteristic: Responds to main demands of autonomous networked learning	Concerned with assessment achievement Purposeful selective interaction with NLE and features Effective time-management and self-motivation Partial preference for lecture-based instruction Requires regular 'seminar' guidance to learn via NLEs
Passive-Autonomous	**Defining Traits**
General characteristic: 'Just-in-time' learning	Concerned with coping Minimal-required interaction with NLE and features Poor time-management and self-motivation Leaves difficulty unresolved Preference for lecture-based instruction Requires structure of traditional courses to learn

Students classified as passive-autonomous had repeatedly delayed their studying, and so negated the potential of their NLEs for reflective, self-paced learning. They did no more than the minimum amount of work to get by, which meant never reading beyond the core materials, rote learning content, posting hastily written discussion contributions to satisfy assessment requirements, and rarely paying more than a cursory level of attention to supportive multimedia elements.

In comparison, active-autonomous students had undertaken networked learning in a purposeful manner, but selectively tailored their interactions according to the perceived demands of their formally assessed learning. Therefore while they made good use of the features provided, they did not utilise all of them.

In contrast, the constructive-autonomous learner was the 'ideal' networked learner, focused on developing a thorough understanding of the subject, and pro-actively interacting with all the available resources to arrive at this point. This included conscientious participation in discussion, following external links, and studying multimedia elements until they had fully comprehended their content. They were completely at ease with studying online, and by fully immersing themselves in this experience was the kind of learner much of the theoretical literature arguably assumes will be interacting with constructivist environments.

Although a fuller consideration of these findings will be reported elsewhere, it is worth noting that while constructive-autonomous learners were in the minority, their assessed learning outcomes demonstrated the most conceptual understanding, and they averaged the most studying time. Passive-autonomous learners were least successful in these respects.

7. The Proposed Framework

An overview of the proposed framework is now provided. Although there is little scope for exploring the underlying empirical evidence in detail, all of the propositions outlined are informed by the findings of the research undertaken, or have a basis in previous studies.

In terms of conceptual foundation, the framework has three basic underlying beliefs:

1. Educational environments consistent with constructivist principles have the potential to facilitate active, student-centered learning leading to rich, transferable knowledge

2. Inherent within the features of NLEs are properties that have the potential to support cognition in ways consistent with constructivist ideas of student-centered learning

3. Individual students have different preferred ways of studying that influence how and what they learn, but which are open to influence by factors within specific contexts

7.1 Nature of Autonomous Networked Learning

The central proposition is that the nature of autonomous networked learning, which encompasses how the individual undertakes networked learning and the effectiveness of the experience for them, can be viewed as an interrelationship between an individual's approach to networked learning, mode of interaction with their NLE, and the features of the environment itself in the form of course content, activities, and other extrinsic factors (Fig 1).

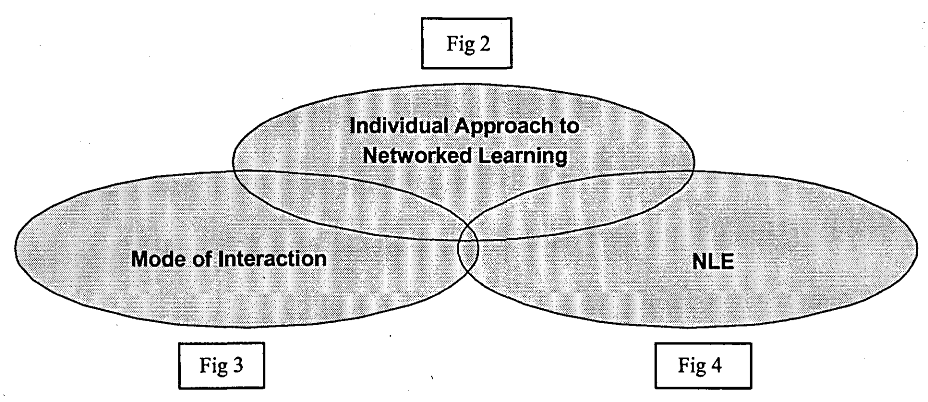


Figure 1: The Nature of Autonomous Networked Learning

Individual approaches are the primary influence on how effectively a student learns online. However the relationship between the factors depicted can be seen as an 'inter-relationship' as there are clearly observable, or strongly implied, dependencies between them. As an example in the former vein, the networked learning approaches identified corresponded to increasing time spent studying and fuller use of NLE resources, both of which help define an individual's mode of interaction, and also to qualitatively better learning outcomes.

The nature of networked learning as depicted above is at a broad level of conceptualisation, with a fuller understanding to be achieved through considering each of the three main factors.

7.2 Nature of Individual Approaches to Networked Learning
The main proposition here is that students undertake networked learning in one of three distinct ways, with each approach on the passive-active-constructive continuum more conducive to effective networked learning. However, a second proposition is that networked learning approaches are an 'emergent property' of how an individual approaches traditional studying, their ease with the nature of networked learning, ease with technology, and understanding of networked learning course objectives (Fig 2).

Previous studies that provide evidence of learning styles influencing interaction with and learning from technology-based environments all, without apparent exception, use instruments designed to assess learning styles in general or conventional educational contexts. Although they offer limited insight for this reason, this does suggest that how individuals typically like to learn can be an influence in educational technology contexts.

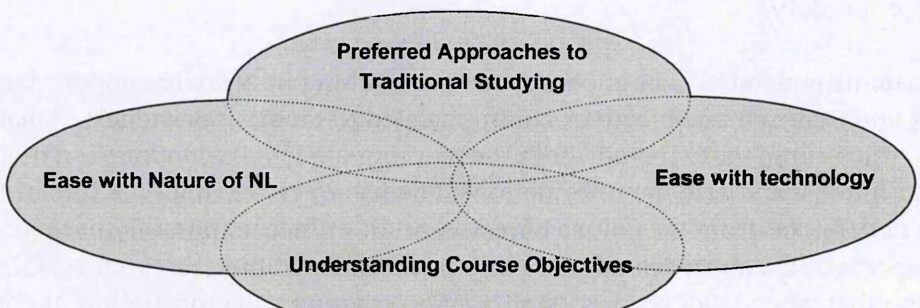


Figure 2: The Nature of Individual Approaches to Networked Learning

In relation to the approaches to studying construct, there is some evidence that those who normally take a deep or strategic approach are better suited to networked learning (Allinson, 1992; Light et al, 1999; Gibbs, 1999). This research drew a similar conclusion. This was obvious within the accounts provided by the students, who often described undertaking networked learning in ways that adhered to their established time management and studying habits. It was also evident when comparing networked learning approach classifications with responses to the Approaches to Studying Inventory. At the sub-scale level of the inventory, constructive-autonomous learners scored highest on all of the deep approach traits, as did active-autonomous learners on the strategic traits, and passive-autonomous learners on the surface traits. This is perhaps unsurprising given that the online approaches identified reflect the same concerns with either understanding, achieving or coping as the deep, strategic and surface classifications. However, the idea of students carrying forth their habitual ways of studying into networked contexts raises some interesting questions, especially concerning how students who require a high level of support will cope working independently online.

Regarding how at ease with the nature of networked learning a student feels, while many campus-based students feel positively about the opportunities it offers them, the majority are opposed to the prospect of learning solely online (Ward & Newlands, 1998; Angulo & Bruce, 1999; Shaw, 2000). It is suggested this is because some students do not possess the appropriate skills or mindset to learn successfully in networked contexts. This certainly applies to the networked learning approaches identified. Constructive-autonomous individuals felt at ease with what networked learning involves. Conversely, passive-autonomous approach learners had a need for the kind of structured studying and support normally associated with lecture-based courses. They also had the least conscious awareness of what networked learning offers them that lecture-based courses do not.

Being at ease with the technology is a given requirement, as an individual who might otherwise take a constructive-autonomous approach will certainly encounter difficulty if they do not possess the necessary IT skills. Yet the majority involved in this research were equipped to this level. This therefore raises a more pertinent issue, and one closely related to being at ease with the nature of networked learning, which is feeling at ease with using the technology for educational purposes. This lies in the difference between knowing how to post messages to a discussion board, and actually appreciating what this facility offers in terms of communicating asynchronously with peers. More broadly, it is the difference between technical competence and knowing how the available resources are intended to support learning, coupled with a willingness to use them appropriately.

What students understand about NLEs, and the learning they are to support, largely depends upon the course objectives communicated to them. It is suggested that in networked learning, these include both the learning objectives contained in module and task descriptions, and also the information students are given about the role of the NLE. What is understood from the course objectives will influence, possibly in fundamental ways, aspects of the approach taken. Early phenomenographic research established this by finding that when students perceived a task to require a demonstration of conceptual knowledge they focused on the meaning in a text, even if they normally rote-learned, and subsequent work has continued to attest to the influence of task perceptions upon learning effectiveness (Entwistle, 1998).

There were several instances in which the objectives communicated resulted in less than optimum interaction with NLEs for the students in this research. This included the poor use of a discussion facility partly because little information about how it was to be used was provided. As a number of such occurrences involved the majority of certain cohorts, they affected individuals of all approach types. Had clearer guidance been provided, presumably active- and constructive-autonomous learners would have made more use of the features over which there was some confusion. As for passive-autonomous individuals, who make minimal use of NLEs anyway, objectives detailing explicit learning requirements would clearly be essential.

This suggests good metacognitive information is also important, and there are many examples of students having been supported in the self-exploration of educational hypertexts by prompts within the material (e.g. Relan & Smith, 1996; Kashihar et al, 1999). Beyond this, it may also help students to approach networked learning effectively if they are given information about why they are to use particular resources, expected benefits, and the skills required to learn online (Sumner & Taylor, 1998; Collis & Meeuwsen, 1999). Although it was not provided to the students in this investigation, this kind of explicit guidance would arguably have proven beneficial – particularly to passive-autonomous learners.

7.3 Nature of Mode of Interaction

Mode of interaction refers to the frequency of interaction with NLE resources, and the extent to which interaction occurs online. It is seen as influenced by individual approach, features of the NLE, reliance on print materials, and studying conditions (Fig 3).

Although approach is the major factor affecting how much time is spent studying, and how well this time is used, it is proposed that specific features of an NLE can influence the amount of learning that occurs online. Within the experiment, students who interacted with NLEs that featured multimedia and or asynchronous discussion facilities had a much higher ratio of reading online than those who used a text-only environment. The presence of visual multimedia was particularly influential, with many students reading at least partially online in order to properly view static images, and to utilise the more interactive elements. In addition a number had read online to access discussion boards as and when required.

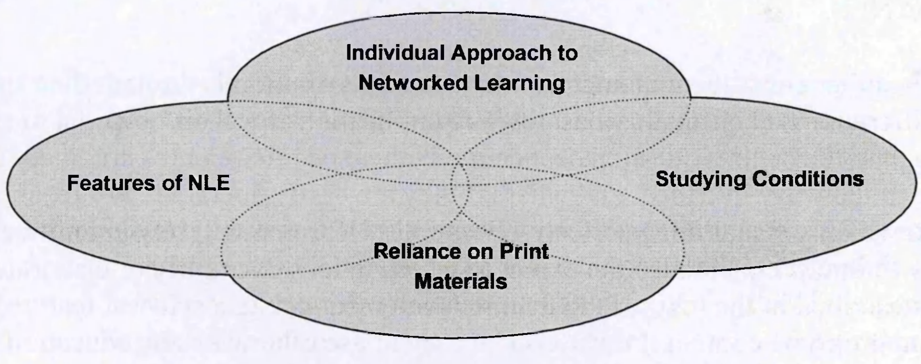


Figure 3: The Nature of Mode of Interaction with NLEs

This has implications for the realisation of networked learning affordances. If students opt to work online because multimedia is available to be interacted with, then presumably at least some individuals will interact with it in ways that are conducive to enhanced cognition. In addition, to engage learners at least partially online so that they can benefit as fully as possible from their NLEs, then perhaps the deliberate inclusion of relevant multimedia and other interactive features, by encouraging online studying, would lead to a better use of, for example, discussion facilities to seek assistance at the point it is required, external links, or self-test features to reflect on a developing understanding. This is highly speculative, and not aided by the influence of NLE features on mode of interaction being an under-researched issue, but the findings in this area of the investigation did suggest a link.

Any influence that specific features have upon how much interaction occurs online will be offset by any preference the individual has for working with print materials. For some this will be a physiological issue, as they will find it harder to read from screen. A partial preference for print may also be based upon the desire to employ established strategies, such as annotating, that students find personally effective. Keeping a paper copy also facilitates literal anytime, anyplace studying. In all these respects students are printing materials to get around limitations of studying online, so while excessive offline studying is problematic as it may negate certain interactions with NLEs, the basic practice can be educationally effective.

The final factor expected to influence mode of interaction are the studying conditions within the physical space from which an NLE is being accessed. This was an important issue for those accessing NLEs from campus labs, which were seen as poor environments for sustained studying due to noise, student movement, etc. This resulted in students working with paper materials, at home if that was an option, or in labs out-with preferred times for studying.

7.4 Nature of the Networked Learning Environment

The third element in the main three-factor relationship is the NLE itself, which encompasses both the features of the environment and the instructional factors associated with it (Fig 4).

The quality of course materials is determined by their explanatory breadth, depth and clarity. This is critical to the success of networked learning, which requires the student to have ownership of the learning process, but often provides little opportunity beyond re-reading to seek immediate help with comprehension. The issue also applies to supporting information about the course, including course objectives and guidance on using the NLE.

As for the other constituent elements, their main contribution is through their quality and proliferation. Their quality has obvious implications for their potential to support learning, and the central questions concern whether specific features are likely to aid learning in the ways intended, and whether they are easily operable. For example, the extent to which a visual image effectively supports learning will rely upon it being clear and easy to interpret, and also the extent to which it does exemplify or elaborate upon what is described in the text. If the feature is interactive, e.g. a self-test feature, then beyond appropriate content it must also be easy to use otherwise any educational benefits may be cancelled out.

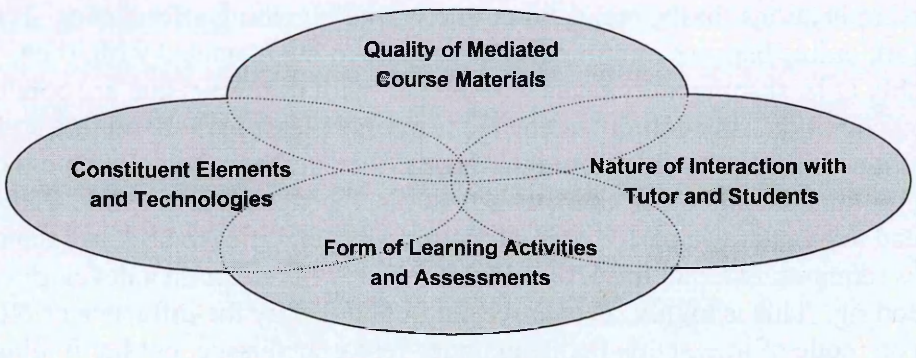


Figure 4: The Nature of the Networked Learning Environment

On their proliferation, the concern is with the presence of specific features wherever appropriate. The wider their range, the richer the range of potential affordances becomes (e.g. multimedia for specific cognitive benefits, external links for elaborated domain exploration, asynchronous discussion for reflective debate). As active-autonomous learners will interact with many NLE features provided, and constructive-autonomous learners with most if not all, there are grounds for assuming a diverse range would be beneficial.

Regarding interaction with tutors and students, the main issues are whether there are opportunities for this, and what form they take. For constructive-autonomous students an important benefit of peer interaction would be for extending their understanding, although for active- and passive-autonomous students it would be in making networked learning feel less isolating. As passive-autonomous learners relied heavily on peer interaction to motivate them in normal course contexts, equivalent opportunities online are critical.

With their self-governing ability, and like of networked learning, constructive-autonomous individuals feel most at ease with the idea of communicating with their tutors entirely online. With their respective needs for structure and guidance in order to learn effectively, it is clear that good provision for regular and on-demand communication from and with the tutor is essential for passive- and active-autonomous networked learners.

For passive-autonomous learners any communication from the tutor may need to be explicit and possibly quite didactic in nature, such is their requirement for direct instruction. Passive-autonomous students value elaborated explanations on issues that relate to formal assignments, and so communication from the tutor would need to be supportive in these respects. The implication is that the tutor, in dealing with a range of needs, would need to be both explicit and supportive in communicating with the group and, unless the type of feedback required was obvious, with individuals online. For passive- and active-autonomous learners in campus-based online contexts, some face-to-face interaction with the tutor will be highly valued. Where interaction is online, the literature is clear on the importance of the tutor being pro-active, responsive and 'visible' online (Berge, 1995; Salmon, 2000).

Constructivist theory suggests learning tasks are most effective when they require students to develop knowledge in ways that reflect the real-world, and proposes that activities like essays and exams are not best suited to learning in resource-rich constructivist environments (Reeves & Okey, 1996; Jonassen, 1999). The findings of this research concurred but offered some additional insight, and it is proposed that networked learning activities should not just be authentic in content, but also periodic in frequency and usually formally assessed.

Where collaborative, problem and case-based activities were undertaken these were viewed as more educationally effective than summative essays and exams, partly because they required different resources within the environment to be utilised rather than only the core materials. The passive-autonomous learners, who procrastinated online, felt that periodic activities with staggered deadlines encouraged more consistent learning than would have otherwise occurred. The implication is that while some individuals will undertake networked learning in a last minute manner, having periodic rather than summative activities at least ensures there are multiple instances of last minute studying. Furthermore if the periodic activities undertaken require different features to be utilised, then even those students who interact fairly minimally with NLE resources will have at least interacted to some degree with a diverse range of them, rather than concentrating their efforts on core materials alone.

Finally, in terms of being assessed, the literature indicates that this influences what most students perceive as "legitimate" networked learning activity, and will therefore undertake with more effort than they would on a voluntary basis (McAteer et al, 1997; Laurillard, 2002). In respectively interacting minimally or selectively online, the implication for those taking either a passive- or active-autonomous approach is that their networked learning efforts may be most effectively supported by being formally assessed wherever reasonable.

8. Applications and Implications

Given the descriptive nature of the framework outlined, any potential applications of it are likely to rest on the insight it tries to offer into the range of factors identified.

8.1 Practical Applications

On a practical level, the proposed framework may hold some value for tutors or course designers who want to reflect on their current or planned use of NLEs, and the issues that might impact how effectively their students learn online. This may lead to a more informed design of NLEs, and approach to supporting students online, on the part of the tutor. It may also increase awareness of the areas in which current courses could be further improved.

8.2 Research Implications

For research purposes, the framework may be of value in highlighting aspects of the networked learning experience that are worth further investigation. This could include the idea of networked learning styles, or the influence of specific features upon how students interact with NLEs. Alternatively, it may act as tool for considering possible explanations for findings from studies into networked learning interactions and outcomes.

It is thought the application of the proposed framework might be aided through the depiction of the factors and inter-factor relationships it describes in a diagrammatic format. A model based on the content of the proposed framework is presented on the next page (Fig 5).

There is still much to be understood in terms of how students undertake networked learning, and the findings that informed the framework indicate that research to date has been limited in important respects. An implication for research into learning styles and educational technology is that it might be more insightful to focus on what students do when interacting with educational technology by asking them directly, rather than trying to understand their interactions through using quantitative learning style tools designed for other purposes.

8.3 Theoretical Implications

The proposed framework has two main theoretical implications. The first is the need for constructivist theory to more directly address the role of the learner. For a theoretical movement founded on the assumption that what we learn is a direct result of idiosyncratic interactions with our environments, and which advocates giving students the freedom to pursue their own paths of enquiry, it is strange that constructivism directs little attention towards the influence that individual ways of working might have upon how students interact with educational environments, and their resulting understanding. That this is an area in which constructivist theory is lacking has not gone unnoticed, although to date only a few leading constructivists have acknowledged that the learner, and related issue of learner compliance, need addressing (e.g. Salomon, 1986; Land & Hannafin, 2000).

The second implication concerns the notion of affordances as it is generally applied to educational technology. The current conception - of affordances being properties of specific tools and resources that will support the cognition of the learner as they interact with them - is arguably a misconception if the idea of networked learning approaches is accepted. Instead, it is probably more appropriate to view the affordances of educational technology as *opportunities for enhanced cognition that have the most potential to support individuals who utilise the technology in effective and purposeful ways*. This is closer in nature to Gibson's (1977, 1979) conception of an affordance as an emergent relationship that exists between an individual and the opportunities for action within objects in their environment.

Gibson also explained that affordances can be negative. What we currently understand about networked learning affordances could be furthered if it is recognised that, for some students, many of the opportunities of networked learning may be largely negative if the student feels unsuited to learning this way, or exploits the opportunity for autonomous learning to repeatedly delay studying. Some theorists have acknowledged this (Salomon, 1986; Pea, 1993; Land & Hannafin, 2000), with the latter recognising that "while tools or resources may *afford* an opportunity for cognitive processing, they may or may not be used mindfully by the learner to extend thinking or understanding" (Ibid, p. 187). On the basis of the research that informed the proposed framework, there may be a need for other theorists to follow suit.

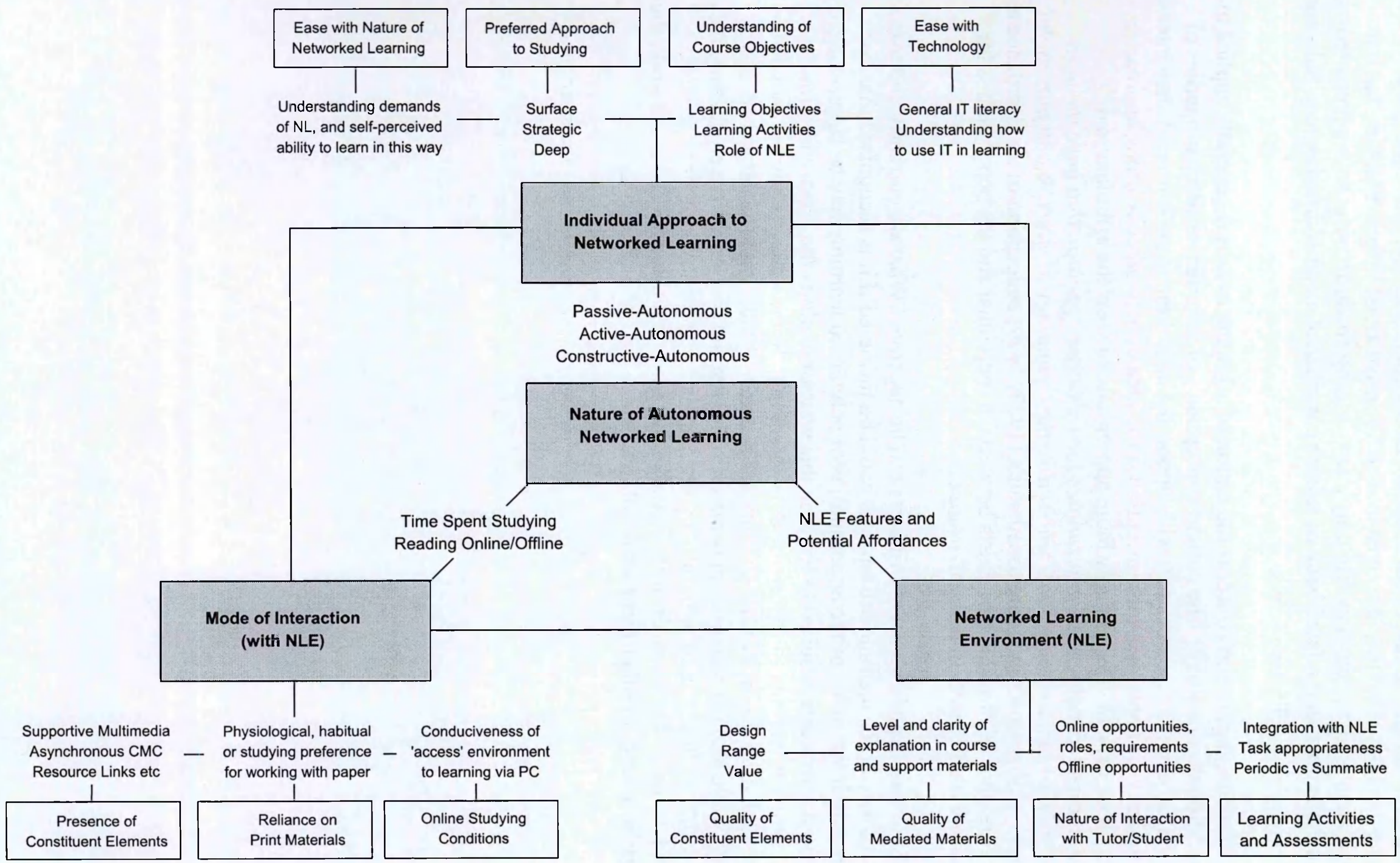


Figure 5: The Nature of Autonomous Networked Learning - A Diagrammatic Model of Key Factors in The Student Experience

9.0 References

Allinson, L. (1992) "Learning styles and computer-based learning environments" in *Computer-assisted learning: lecture notes in computer science* (Vol 602), I. Tomek (Ed), Springer-Verlag, pp61-73.

Angulo, A.J. and Bruce, M. (1999) "Student perceptions of supplemental web-based instruction", *Innovative Higher Education,* Vol 24, No.2, pp.105-125.

Beasley, N. and Smyth, K. (2004) "Expected and actual student use of an online learning environment: a critical analysis". *EJEL,* Vol 2, Issue 1. Available online at: http://www.ejel.org/index.htm.

Bell, P. and Winn, W. (2000) "Distributed cognitions, by nature and design" in *Theoretical Foundations of Learning Environments,* D.H. Jonassen and S.M. Land (Eds), Lawrence Erlbaum, pp123-146.

Berge, Z.L. (1995) "Facilitating computer conferencing: recommendations for the field", *Educational Technology,* Vol 15, No.1, 22-30.

Conole, G. and Dyke, M. (2004) "What are the affordances of information and communication technologies?", *ALT-J,* Vol 12, No 2, pp115-124.

Collis, B. and Meeuwsen, E. (1999) "Learning to learn in a WWW-based environment" in Internet-based learning: an introduction and framework for higher education and business, C. Johnson, C.Hale, D.French and G. Farr (Eds.), Kogan Page, pp25-46.

Crook, C. K. (1997) "Making hypertext lecture notes more interactive: undergraduate reactions", *Journal of Computer Assisted Learning,* Vol 13, pp.236–244.

CTGV (1993) "Integrated media: toward a theoretical framework for utilizing their potential", *Journal of Special Education Technology,* Vol 12, No.2, pp71-85.

Entwistle, N. (1998) "Approaches to learning and forms of understanding" in *Teaching and learning in higher education,* B. Dart, G. Boulton-Lewis (Eds), ACER Press, pp72-101.

Entwistle, N. (2001) "Styles of learning and approaches to studying in higher education", *Kybernetes,* Vol 30, No 5/6, pp.593-602.

Gibbs, G.R. (1999) "Learning to learn in a virtual environment for philosophy", *Journal of Computer Assisted Learning,* Vol 15, No.3, pp221-231.

Gibson, J.J. (1979) *The ecological approach to visual perception.* Boston: Houghton Mifflin.

Gibson, J.J. (1977) "The theory of affordances" in *Perceiving, acting and knowing,* R. Shaw & J. Bransford (Eds.), Lawrence Erlbaum, pp67-82.

Goodyear, P. (1999) *Environments for lifelong learning: ergonomics, architecture, and the practice of learning technology,* CSALT report, Available online at: http://domino.lancs.ac.uk/edres/csaltdocs.nsf.

Goodyear, P., Banks, S., Hodgson, V. and McConnell, D. (Eds) (2004a) *Advances in Research on Networked Learning,* Kluwer.

Jacobson, M.J. and Spiro, R.J. (1995) "Hypertext learning environments, cognitive flexibility and the transfer of complex knowledge: an empirical investigation", *Journal of Educational Computing Research,* Vol 12, No.5, pp301-333.

Jonassen, D.H. (1992) "Cognitive flexibility theory and its implications for designing CBI" in *Instructional models in computer-based learning environments,* S. Dijkstra, H.P.M. Krammer and J.J.G Van Merrienboer (Eds), Springer-Verlag, pp385-403.

Jonassen, D.H. (1999) "Designing constructivist learning environments" in *Instructional design theories and models: a new paradigm of instructional theory,* C.M. Reigeluth (Ed), Lawrence Erlbaum, pp215-239.

Karuppan, C.M. (2001) "Web-based teaching materials: a user's profile", *Internet Research - Electronic Networking Applications,* Vol 11, No 2, 138-148.

Kashihara, A., Hiroshi, U. and Toyoda, J. (1999) "Reflection support for learning in hyperspace", *Educational Technology*, Vol. 39, No.5, 19-22.
Land, S.M. and Hannafin, M.J. (2000) "Student-centered learning environments" in *Theoretical Foundations of Learning Environments,* D.H. Jonassen and S.M. Land (Eds), Lawrence Erlbaum, pp1-24.
Laurillard, D. (2002) *Rethinking university teaching (2nd Edition)*, Routledge.
Lee, Y.B. and Lehman, J.D. (1993) "Instructional cuing in hypermedia: a study with active and passive learners", *Journal of Educational Multimedia and Hypermedia*, Vol 2, No 1, pp25-37.
Light, P., Colbourn, C. and Light, V. (1997) "Computer mediated tutorial support for conventional university courses", *Journal of Computer Assisted Learning*, Vol 13, pp228-235.
Marton, F. (1994) "Phenomenography" in *International encyclopaedia of education*, T. Husen and N. Postlethwaite (Eds), Pergamon, pp4424-4429.
Mason, R. (1994) *Using Communications Media in Open and Flexible Learning*, Kogan Page.
Mayer, R.E (2001) *Multimedia learning*, Cambridge.
McAteer, E., Tolmie, A. Duffy, C. and Corbett, J. (1997) "Computer-mediated communication as a learning resource", *Journal of computer-assisted learning*, Vol 13, 219-227.
McConnell, D. (2000) *Implementing Computer Supported Cooperative Learning (2nd Edition)*, Kogan Page.
Miller, S.M. and Miller, K.L (2000) "Theoretical and practical considerations in the design of web-based instruction" in *Instructional and cognitive impacts of web-based education,* B. Abbey (Ed), Idea Group Publishing, pp156-177.
Pea, R.D. (1993) "Distributed multimedia learning environments: how and why?", *Interactive Learning Environments*, Vol 2, No.2, 73-109.
Reeves, T.C and Okey, J.R. (1996) "Alternative assessment for constructivist learning environments" in *Constructivist learning environments: case studies in instructional design*, B.G. Wilson (Ed), Educational Technology Publications, pp191-202.
Relan, A. and Smith, W.C. (1996) "Learning from hypermedia: a study of situated versus endemic learning strategies", *Journal of Educational Multimedia and Hypermedia*, Vol 5, No.1, 3-21.
Ryder, M. & Wilson, B. (1996) "Affordances and constraints of the internet for learning and instruction" in *18th annual proceedings of AECT*, M.R. Simonson (Ed), pp.642-654.
Salmon, G. (2000) *E-moderating: the key to teaching and learning online*, Kogan Page.
Salomon, G. (1986) "Information technologies: what you see is not (always) what you get", *Educational Psychologist,* Vol 20, No 4, 207-216.
Smeaton, A.F. and Keogh, G. (1999) "An analysis of the use of virtual delivery of undergraduate lectures", *Computers and Education,* Vol 32, No.1, pp83-94.
Sumner, T. and Taylor, J. (1998) "Media integration through meta-learning environments" in *The knowledge web: learning and collaborating on the net*, M. Eisenstadt and T. Vincent (Eds), Kogan Page, pp63-78.
Taraban, R., Maki, W.S. and Rynearson, K. (1999) "Measuring study time distributions: implications for designing computer-based courses", *Behavior Research Methods, Instruments and Computers*, Vol 31, No.2, pp263-269.
Ward, M. and Newlands, D (1998) "Use of the W :b in undergraduate teaching", *Computers & Education*, Vol 31, pp.171–184.
Windschitl, M. (1998) "The WWW and classroom research: what path should we take?", *Educational Researcher,* Vol 27, No.1, 28-33.